

Function generator 1 mHz – 20 MHz

PM 5134

Instruction manual
Gerätehandbuch
Mode d'emploi et d'entretien

9499 453 00402

Sixth Edition
890701



PHILIPS

Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s. v. p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschulitem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.



Philips GmbH — Hamburg — Germany — 1989

Him

All rights are strictly reserved.

Reproduction or divulgation in any form whatsoever is not permitted without written authority from the copyright owner.

Issued by Philips GmbH -Unternehmensbereich Elektronik für Wissenschaft und Industrie- Werk für Meßtechnik

Printed in Germany

CONTENTS

1.	GENERAL	E 1-1
1.1.	Introduction	E 1-1
1.2.	Technical data	E 1-2
1.3.	Accessories	E 1-9
1.4.	Operating principle	E 1-10
2.	INSTALLATION INSTRUCTIONS	E 2-1
2.1.	Initial inspection	E 2-1
2.2.	Safety instructions	E 2-1
2.3.	Mains voltage setting and fuses	E 2-2
2.4.	Operating position of the instrument	E 2-2
2.5.	Dismantling the instrument	E 2-2
2.6.	Radio interference suppression	E 2-2
3.	OPERATING INSTRUCTIONS	E 3-1
3.1.	Controls and sockets	E 3-1
3.2.	Operation	E 3-3
4.	SERVICE PART	4-1
4.1.	Circuit description	4-1
4.2.	Access to parts	4-17
4.3.	Check and adjustment	4-18
4.4.	Safety inspection and tests after repair and maintenance	4-21
4.5.	Spare parts	4-22
5.	FIGURES 30 – 47	
Fig. 30	Block diagram	
Fig. 31	Front view	
Fig. 32	Rear view	
Fig. 32a	Back plate (internal view)	
Fig. 33	Handle: spare parts	
Fig. 34	Mains cable: spare parts	
Fig. 37	Overall circuit diagram	
Fig. 38	Unit 1, switches, adjusting elements	
Fig. 39	Unit 1, component lay -out	
Fig. 40	Unit 4, component lay -out	
Fig. 41	Unit 1, part 1, circuit diagram	
Fig. 42	Unit 1, part 2, circuit diagram	
Fig. 43	Unit 1, part 3; unit 4; circuit diagrams	
Fig. 44	Unit 2, component lay -out	
Fig. 45	Unit 3, component lay -out	
Fig. 46	Unit 2, part 1; unit 3; circuit diagrams	
Fig. 47	Unit 2, part 2, circuit diagram	
6.	CODING SYSTEM OF FAILURE REPORTING FOR QUALITY	
7.	ADDRESSES FOR SALES AND SERVICE	

INHALTSVERZEICHNIS**TABLE DES MATIERES**

1.	ALLGEMEINES	D 1-1	GENERALITES	F 1-1
1.1.	Einleitung	D 1-1	Introduction	F 1-1
1.2.	Technische Daten	D 1-2	Caractéristiques techniques	F 1-2
1.3.	Zubehör	D 1-9	Accessoires	F 1-9
1.4.	Funktionsprinzip	D 1-10	Principe de fonctionnement	F 1-10
2.	VORBEREITUNGS- ANWEISUNGEN	D 2-1	INSTRUCTIONS POUR L'INSTALLATION	F 2-1
2.1.	Wareneingangskontrolle	D 2-1	Inspection initiale	F 2-1
2.2.	Sicherheitsanweisungen	D 2-1	Consignes de sécurité	F 2-1
2.3.	Netzspannungseinstellung u. Sicherungen	D 2-2	Adaptation à la tension secteur, fusibles	F 2-2
2.4.	Betriebslage des Gerätes	D 2-2	Position de fonctionnement de l'appareil	F 2-2
2.5.	Öffnen des Gehäuses	D 2-2	Démontage de l'appareil	F 2-2
2.6.	Funkentstörung	D 2-2	Suppression du rayonnement	F 2-2
3.	BETRIEBSANLEITUNG	D 3-1	MISE EN SERVICE	F 3-1
3.1.	Bedienelemente und Anschlüsse	D 3-1	Commandes et douilles	F 3-1
3.2.	Bedienung	D 3-3	Fonctionnement	F 3-3
5.	BILDVERZEICHNIS		RAPPEL DES FIGURES	
Fig. 30	Blockschaltbild		Fig. 30	Schéma synoptique
Fig. 31	Frontansicht		Fig. 31	Face avant
Fig. 32	Rückansicht		Fig. 32	Face arrière

Operating manual



1. GENERAL

1.1. INTRODUCTION

The PM 5134 is an easy-to-use yet sophisticated function generator embodying a wide range of facilities in a single instrument.

It produces sine, square and triangle wave forms as well as positive or negative pulses and DC. The duty cycle is variable between 10% and 90%.

The 1mHz to 20MHz frequency range is selected by means of a 10-position rotary switch with an overriding coarse/fine adjustment. This fine adjustment, combined with the 3 1/2 digit LED display, gives an immediate, highly accurate readout of the selected frequency.

Setting up procedures are thus very much simplified compared with the traditional dial setting and any human errors (e.g. parallax) are eliminated.

In addition, the 3 1/2 digit display can be used to monitor the open-circuit output voltage. Also, when used in the sweep mode, the start, stop and run frequencies are indicated by separate LEDs. Moreover, an error warning lamp automatically indicates any incompatible setting-up conditions.

The high, nominal accuracy of $\pm 2\% \pm 1$ digit, can be further improved to $\pm 5 \times 10^{-6}$ by operating the instrument in the crystal-control mode. This facility is useful, for example, for identical repetitive measurements requiring high accuracy, or for narrow band filter tests. The X-TAL AM mode offers a stable carrier wave with defined frequency. One particular application is when using a 10.7 MHz carrier frequency to check that the discriminator section of a radio receiver is suppressing the AM wave form.

The continuously variable 20Vpp max output (10Vpp for pulses) is available at the front panel socket; there is a pushbutton choice of 600Ω or 50Ω output impedance. The output attenuation is selectable in any combination of 3-6-10-20dB pushbuttons with an overriding continuous 20dB control.

Sweep facilities include single and continuous operation. The single sweep can be triggered either manually, or electronically from an external source. The sweep period is continuously adjustable between 5ms and 100s. The START and STOP frequencies are non-interactive and can be set independently of each other. A HOLD facility allows a sweep to be stopped at any desired frequency — useful for checking phenomena occurring during a sweep — by means of a pushbutton. An interrupted sweep is continued by simply releasing the HOLD button. If required a sweep can be reset to the start frequency using the RESET pushbutton.

The generator offers an internally or externally controlled burst or single-cycle signal. The start/stop phase is continuously adjustable between -90° and $+90^\circ$.

The internal AM is adjustable between 0 and 100% modulation depth. The modulation frequency can be set over a wide range from 10mHz to 20kHz. The AM facility can be used with crystal control, if desired. External AM inputs in the range from DC to 20kHz can be applied via a rear-mounted BNC-socket.

The internal FM can be continuously adjusted between zero and $\pm 10\%$ frequency deviation.

Other input/output facilities available on the rear panel include a TTL output and pen lift control.

The design of the PM 5134 has resulted in a clean, simple front panel layout which allows the operator to become quickly familiar with all control functions. Its overall versatility makes it suitable for a wide range of applications within research, design or educational organisations. The instrument occupies minimal bench space.

1.2. TECHNICAL DATA

Safety characteristics

This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains some information and warnings which must be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

Performance characteristics, specifications

Properties expressed in numerical values with stated tolerance are guaranteed by the manufacturer. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.

This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23 °C).

If not stated otherwise, relative or absolute tolerances relate to the set value.

1.2.1. Frequency

frequency range	1 mHz – 20 MHz
selected ranges I	1 mHz – 20 mHz
II	10 mHz – 200 mHz
III	0.1 Hz – 2 Hz
IV	1 Hz – 20 Hz
V	10 Hz – 200 Hz
VI	100 Hz – 2 kHz
VII	1 kHz – 20 kHz
VIII	10 kHz – 200 kHz
IX	100 kHz – 2 MHz
X	1 MHz – 20 MHz $\pm 5\%$
for X-TAL mode ranges IV – X only	1 Hz – 20 MHz
characteristic	linear
adjustments	<ul style="list-style-type: none"> – range switch FREQ. RANGE – FREQUENCY knobs for coarse and fine setting – pushbutton X-TAL LOCK/TUNE
vernier frequency adjustment	$\pm 5\%$ of end of range
display	3 1/2 digit 7-segment LED display 3 decimal points 4 LEDs for dimensions mHz, Hz, kHz, MHz
setting error	range I to IX: $\pm 2\% \pm 1$ digit X: $\pm 5\% \pm 1$ digit
– for X-TAL mode	$\pm 5 \cdot 10^{-6}$
temperature coefficient	range I to IX: $< 0.1\%/\text{K}$ X: $< 0.3\%/\text{K}$
– for X-TAL mode	$< 2 \cdot 10^{-6}/\text{K}$
short-term drift	range I to IX: $< 0.1\%$ X: $< 0.4\% \quad \} \text{ within } 15 \text{ min}$
– for X-TAL mode	range IV to IX: $< 1 \cdot 10^{-6} \quad \} \text{ within } 15 \text{ min}$ X: $< 5 \cdot 10^{-6} \quad \}$

long-term drift – for X-TAL mode	range I to IX: < 0.3 % X: < 0.6 % } < $0.5 \cdot 10^{-6}$ } within 7 h
1.2.2. Output	
connection	BNC socket
impedance	50Ω/600Ω, selected by pushbutton
load capability	short-circuit proof
wave forms	<ul style="list-style-type: none"> ~ sine wave ~ triangular wave □ square wave — positive pulse — negative pulse <p>all with or without DC offset; DC d.c. voltage without a.c.</p>
duty cycle	continuously adjustable from 10% to 90% when pushbutton DUTY CYCLE is pressed; in range X not possible
amplitude, open circuit	<p>2 Vpp . . . 20 Vpp for sine, triangle, square wave 1 Vpp . . . 10 Vpp for pulses ± 10 V (for details see chapter 3.2.3.)</p> <p>3 1/2 digit 7-segment LED display, alternative to frequency display, selected by pushbutton AMPL/FREQ, step attenuation ignored</p>
– limit	$\pm 3\%$ of end of range, at 1 kHz sine and square wave
– display	
– display error	
DC (offset) voltage, open circuit	continuously adjustable from -5 V to +5 V, when pushbutton DC OFFSET pulled
attenuation	
– continuous	0 . . . 20 dB (see open circuit voltage 2 Vpp . . . 20 Vpp)
– fixed	0, 3, 6, 10, 20 dB, selectable in any combination
amplitude response (sine wave; reference value 2 kHz)	<p>< 0.1 dB in ranges III to VIII < 0.5 dB in ranges I to IX < 1.5 dB in range X</p> <p>(open circuit voltage 20 Vpp, attenuator 0 dB, output impedance 50 Ω, load 50 Ω)</p>
distortion (sine wave)	<p>< 0.5% in ranges IV to VIII < 3.0% in ranges I to IX <i>38.2 - 3.0 = 35.2</i>, 46 dB</p> <p>range X: all harmonics more than 26 dB below the fundamental</p>
linearity (triangular wave)	better than 99% up to 100 kHz
rise time, fall time (square wave)	< 18 ns at max. amplitude, into 50Ω
overshoot and ringing (square wave)	< 3% at max. amplitude, into 50Ω

1.2.3. TTL OUTPUT

frequency, duty cycle	as main output, duty cycle referred to 'active low': 
fan out	5 TTL inputs
level	standard TTL level: high > 2.4 V low < 0.8 V
external voltage	not proof against external voltage > 5 V

1.2.4. Sweep, internal

operating modes	– single sweep, manually started by pushbutton TRIG – single sweep, electronically started via TRIG & BURST input – continuous sweep
max. sweep range	2 decades
sweep characteristic	linear
start frequency	continuously coarse and fine adjustable within the selected sweep range; displayed when pushbutton STD BY is pressed
stop frequency	identical to the frequency setting in normal mode both frequencies are independently adjustable; the start frequency may be set higher or lower than the stop frequency
display	as for normal mode (start or stop frequency); 3 LEDs for STOP, RUN, START in addition
sweep period range	5 ms to 100 s, adjustable in 4 sub-ranges
– sub-ranges	0.005 – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
sweep control elements	– pushbutton TRIG to start a single sweep – pushbutton HOLD to stop the running sweep immediately – pushbutton RESET for resetting during the sweep to the start frequency
sweep indication	LED 'RUN'
sweep voltage at MODULATION OUTPUT	BNC socket at the rear side
– output voltage	0 V ... +5 V ($\hat{=} f_{\text{START}} \dots f_{\text{STOP}}$)
– impedance	10 k Ω

PEN LIFT OUTPUT	BNC socket at the rear side; electronic switch, closed during the sweep, open during fly-back
	max. current: 200 mA } electronic switch output voltage: < 0.7 V } closed
	output voltage: +20 V } electronic switch internal resistance: 100 kΩ } open
1.2.5. Frequency control, external	
SWEEP/FM INPUT	BNC socket at the rear side for external control signal for normal mode
voltage vs. frequency characteristic	linear, 1 V/0.2 f_{max} , where f_{max} represents the upper limit of the corresponding sub-range
max. sweep range	2 1/2 decades
max. sweep frequency	200 Hz for a sweep of 1 1/2 decades; sweep voltage: sawtooth, duty cycle 90%
modulation frequency range	DC to 20 kHz, adjustable as MOD/PERIOD > 0.05 ms
input impedance	5 kΩ
TRIG & BURST INPUT	BNC socket at the rear side for external trigger signal for single sweep
– trigger signal	negative going edge from $\geq +2.2$ V to ≤ -0.8 V, e.g. H/L transition of a TTL signal
– max. input voltage	± 15 V
– input impedance	1 TTL input
1.2.6. Burst control, internal	in ranges I to IX
operating modes	repetitive or single triggering
duty cycle, repetitive operation	$\approx 50\%$; each burst is terminated at the start/stop level
repetition time, repetitive operation	0.05 ms to 100 s, continuously adjustable within 6 sub-ranges MOD/SWEEP PERIOD
– sub-ranges	0.05 – 1 ms 0.5 – 10 ms 5 ms – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
burst duration for single operation	as repetition time for repetitive operation
single triggering	manually (internal) or electronically via TRIG & BURST INPUT as for internal sweep

start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90° to +90°)
voltage at MODULATION OUTPUT	TTL-high level: during burst period TTL-low level: during off period
– impedance	250 Ω (pull-up)
1.2.7. Burst control, external	in ranges I to IX
TRIG & BURST INPUT	for external TTL signal; at L/H transition the burst starts; after H/L transition the last cycle is terminated at the start/stop level on the positive slope
max. control frequency	2 MHz
max. input voltage	±15 V
input load	1 TTL input
start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90° to +90°)
1.2.8. SINGLE MODE	in ranges I to IX
triggering	
– manually	with pushbutton TRIG
– electronically	via TRIG & BURST INPUT or internal repetitive
repetition period for internal triggering	0.05 ms to 100 s; continuously adjustable within 6 sub-ranges MOD/SWEEP PERIOD
– sub-ranges	0.05 – 1 ms 0.5 – 10 ms 5 ms – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90° to +90°)
voltage at MODULATION OUTPUT	TTL-high level: during single period TTL-low level: during off period
output impedance	250 Ω (pull-up)
max. trigger frequency	2 MHz for external triggering
external trigger voltage	TTL level
max. input voltage	±15 V
max. input load	1 TTL input

1.2.9. Modulation

Frequency modulation, internal	sine wave
modulation depth	0 to 10%, continuously adjustable
modulation frequency	0.01 Hz to 20 kHz, continuously adjustable within 6 sub-ranges (reciprocal to the modulation period: 100 s - 10 s - 1 s - 0.1 s - 10 ms - 1 ms)
modulation voltage at MODULATION OUTPUT – output load	3 Vpp, independent of depth 1 kΩ
Amplitude modulation, internal	sine wave
modulation depth	0 . . . 100%, continuously adjustable
modulation frequency	0.01 Hz to 20 kHz, continuously adjustable within 6 sub-ranges (reciprocal to the modulation period: 100 s - 10 s - 1 s - 0.1 s - 10 ms - 1 ms)
modulation voltage at MODULATION OUTPUT – output load	3 Vpp, independent on AM depth 1 kΩ
Amplitude modulation, external	
modulation wave form	arbitrary with spectral components up to 20 kHz
modulation frequency	DC to 20 kHz
modulation depth	0 to 2 A _{Tr} , A _{Tr} ≡ unmodulated carrier amplitude
modulation voltage	2 Vpp for 50% AM
connector	BNC socket AM INPUT, rear side
– input impedance	20 kΩ, internal modulator switched off

1.2.10. X-TAL MODE

frequency setting and display	as for NORMAL MODE, if AMPL/FREQ is unlocked
frequency lock with pushbutton LOCK/TUNE	freezes the instant frequency display
settling time	< 3 s for ranges V to X < 30 s for range IV

X-TAL AM MODE

as X-TAL MODE with additional internal or external AM facility

1.2.11.	Error indication for unallowed operating modes	LED 'ERROR' indicates unallowed settings, see chapter 3.2.7
1.2.12.	Power supply	ac mains
	reference value	220 V
	nominal values	110 V/128 V/220 V/238 V, selectable by solder links
	nominal operating range	±10% of selected nominal value
	operating limits	±10% of selected nominal value
	nominal frequency range	50 - 60 Hz
	limit range of operation	47.5 - 63 Hz
	power consumption	55 W
1.2.13.	Environmental conditions	
	Ambient temperature:	
	reference value	+23° C ±1 K
	nominal working range	+ 5° C ... +40° C
	limits for storage and transport	-40° C ... +70° C
	Relative humidity:	
	reference range	45 ... 75%
	nominal working range	20 ... 80%
	limit range of operation	10 ... 90%
	limits for storage and transport	0 ... 90%
	Air pressure:	
	reference value	1000 ± 15 hPa
	nominal working range	798 ... 1064 hPa
	Air speed:	
	reference value	0 ... 0.2 m/s
	nominal working range	0 ... 0.5 m/s
	Operating position	normally upright on feet or with handle fold down
	Warm-up time	30 min.
1.2.14.	Cabinet	
	protection type (see DIN 40 050)	IP 20
	protection class (see IEC 348)	class I, protective conductor
	overall dimensions	
	– height	140 mm
	– width	310 mm
	– depth	390 mm
	weight	approx. 6.5 kg (14 lbs)

1.3. ACCESSORIES

1.3.1.	Standard	instruction manual fuse labels for power supply
1.3.2.	Optional	PM 9585: 50Ω termination 1 W PM 9581: 50Ω termination 3 W PM 9075: Coaxial connection cable BNC-BNC 75Ω PM 9051: Adapter BNC (male) – Banana (female)

1.4. OPERATING PRINCIPLE (Fig. 30)

The functional block modulation oscillator control controls the integrator and the modulation sine shaper according to the actual operating mode.

When the switch MODE is set to SWEEP and the button STD BY/CONT is pressed, the start frequency of the main oscillator can be adjusted. When the button TRIG is operated or triggered by an appropriate pulse at the socket TRIG & BURST, the integrator begins one cycle of a saw-tooth voltage. Analogous to this, the frequency of the main oscillator continuously runs to the adjusted STOP-frequency and quickly flies back to the START frequency.

This process can also be initiated by locking out the STD BY/CONT button; but then the integrator generates a sawtooth voltage periodically repeated. The integrator can be stopped at any value by the button HOLD respectively can be set back to the start-condition with the button RESET. The duration of the period of the sawtooth voltage can be adjusted by the switch MOD/SWEEP PERIOD and the potentiometer PERIOD.

During the forward ramp of the sawtooth voltage, an electronic contact in the modulation oscillator control is "closed" which connects the socket PEN LIFT to ground. During fly-back the connection is open.

In positions FM, AM, and X-TAL AM of the switch MODE the integrator generates a zero-symmetrical triangular voltage, which is converted to a sine wave in the modulation sine shaper. The depth respectively the degree of the modulation are adjustable by the AM/FM DEPTH potentiometer.

In the positions BURST and SINGLE, the main oscillator can be controlled with the TTL-signal of the integrator via the burst control.

According to the operating mode the applied control voltage (saw-tooth or square wave) of the modul. oscillator is fed to the socket MODULATION OUTPUT.

All values controlling the frequency of the main oscillator are combined by the control section to one internal control voltage, being proportional to the frequency.

According to the operating mode, this voltage is dependent on the position of the potentiometer STOP FREQ or START FREQ, on the sweep or FM-voltage of the modulation oscillator, and on the external voltage at the socket SWEEP/FM. The controlling voltage is digitized —when the AMPL / FREQ—key is not pressed— by the analog to digital converter ADC and is displayed as a frequency. The control section provides two charging currents for the main oscillator which are proportional to the driving voltage. When the DUTY CYCLE button is pressed and when the potentiometer DUTY CYCLE is adjusted correspondingly, the charging currents have different values and are variable. Their ratio determines the duty-cycle of the signal generated by the main oscillator. Within the frequency range of 20 MHz the duty cycle is not changeable.

The integration capacitors comprises the frequency-determining capacities of the main oscillator. They are selected by the FREQ RANGE switch.

The triangular voltage of the main oscillator is lead directly via the switching stages to the output channel. The square-wave voltage must be processed for further use in the signal conditioner. The outputs of this functional block are routed to the output TTL, to x-tal control, to the square wave generator and the burst control.

By means of the burst control the SINGLE and BURST functions of the main oscillator are controlled. If the trigger input of the BURST control has switched over to TTL-high level, the main oscillator is able to run free; if the trigger input is set to TTL-low level, the main oscillator is blocked after reaching the chosen Start/Stop phase. The signals are generated by the modulation generator; the signals may also be applied to the input TRIG & BURST.

The square-wave generator forms –dependent upon the adjusted WAVE FORM– a zero-symmetric square-wave voltage or positive or negative square-wave pulses out of the square-wave voltage of the signal conditioner.

The triangular voltage is switched by the WAVE FORM switch either to the sine shaper or to the buffer. With the operating mode AM and X-TAL AM of the switch MODE, the amplitude modulator is switched into the signal path.

Modulation is effected with the voltage of the modulation oscillator or with an external voltage at the socket AM.

The voltage adjusted at the regulator AMPLITUDE is amplified by the power amplifier to a maximum of 20 Vpp. This alternating voltage can be superimposed with a direct current by the potentiometer DC OFFSET.

The attenuator operated by the switches ATTENUATION allows an exact reduction at choice within the combinable stages 3, 6, 10 and 20 dB. The inner resistance of the OUTPUT can be switched over via the button $600 \Omega/50 \Omega$ in the $600 \Omega/50 \Omega$ selector.

Tandem potentiometer AMPLITUDE causes the ampl display conditioner to produce a d.c. voltage being proportional to the amplitude. When the AMPL/FREQ button is pushed this voltage is indicated as open-circuit voltage of the generator. The indicated values of the voltage for pulse signals or AM mode are half as big as for zero-symmetrical signal wave forms. This is organized by the WAVE FORM switch in the ampl display conditioner.

In the display, the LEDs of the dimension and status indication, and also the decimal points in the 7-segment display units are controlled by the LED control. The X-tal control circuit is only switched on by the switch MODE in the X-TAL operating modes.

The frequency indicated by the display is stored in the memory. When the button X-TAL LOCK is pressed, these contents are fixed; thus a possible jumping of the last digit is inhibited. When the button AMPL/FREQ is pressed, amplitude indication is chosen and the last indicated frequency stays stored in the memory.

In the operating modes X-TAL the frequency of the main oscillator exactly corresponds to the value indicated by the display.

The generation of the charging current in the control section is controlled in this case by the output of the summing amplifier. This adds the roughly graduated output voltage of the DAC and the output voltage of the phase detector and integrator which alters finely. The output voltage of the DAC corresponds to the 6 most significant bits of the contents of the memory. The range between two adjacent voltage steps is overlapped by the regulating voltage of the phase detector & integrator. The nominative actual comparison, the result of which is the regulating voltage, is performed according to two different processes. The block diagram shows the position of the switch in the frequency ranges of 20 Hz to 20 kHz, this will be looked into the following.

The actual frequency of the main oscillator sensed at the signal conditioner passes the first variable prescaler I without being divided and arrives at an input of the phase detector and integrator. The nominal frequency is generated in a PLL-system. In this system the programmable frequency divider divides the output frequency of the functional block phase detector and integrator and VCO by the contents of the memory loaded by the ADC. In the steady state, the output frequency of the programmable frequency divider is equal to the 200 Hz frequency of the x-tal stabilized reference oscillator. The controlled VCO-frequency is thus the memory contents multiplied by 200 Hz.

In the second variable prescaler II the VCO frequency is divided according to the chosen FREQ RANGE. From there it is switched to the nominal frequency input of the phase detector and integrator. The capacities of the integrator are switched over dependent on the frequency range. The regulating voltage results from the direct phase comparison between actual and nominal frequency and the consecutive integration.

In the frequency ranges 200 kHz to 20 MHz the x-tal control switches take over the position not depicted. Then the phase detector & integrator & VCO and the second variable prescaler II are out of action. The actual frequency is divided dependent on the range by the variable prescaler I, the output frequency of which is divided by the programmable frequency divider by the contents of the memory. The result is compared by the phase detector & integrator with the nominal frequency at the 100 Hz output of the reference oscillator.

The regulating voltage originates in this case out of the phase comparison between the actual frequency which is divided down to 100 Hz in its steady state and the 100 Hz nominal frequency.

The power supply provides the d.c. voltages for the circuitries and the supply voltage for the fan.

The unit is switched on and off with the switch POWER.

2. INSTALLATION INSTRUCTIONS

2.1. INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occurred during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

2.2. SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations, see para. 1.2. To maintain this condition and to ensure safe operation, the instructions below must carefully be followed.

2.2.1. Maintenance and repair

Failure and excessive stress:

If the instrument is suspected of being unsafe, take it out of operation permanently.

This is the case when the instrument

- shows physical damage
- does not function anymore
- is stressed beyond the tolerable limits (e.g. during storage and transportation)

Dismantling the instrument: When removing covers or other parts by means of tools, live parts or terminals could be exposed. Before opening the instrument, disconnect it from all power sources.

If the **open live instrument needs calibration, maintenance or repair**, it must be performed only by trained personnel being aware of the risks. After disconnection from all power sources, the capacitors in the instrument may remain charged for some seconds.

2.2.2. Earthing (grounding)

Before any other connection is made the instrument shall be connected to a protective earth conductor via the three-core mains cable. The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

The external contacts of the BNC sockets must not be used to connect a protective conductor.

WARNING: Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

The circuit earth potential applied to the external contacts of the BNC sockets is connected to the cabinet. The external contacts of the BNC sockets must not be used to connect a protective conductor.

2.2.3. Connections

The circuit earth potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected capacitor and resistor. By this means hum loops are avoided and a clear HF earthing is obtained.

If the circuit earth potential in a measurement set-up is different from the protective earth potential, it must be noticed,

- that the BNC sockets can be touched and that it must not be live, see the safety regulations on the subject (VDE 0411),
- that all sockets marked with the sign \perp are internally interconnected.

2.2.4. Mains voltage setting and fuses

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.

The instrument shall be set to the local mains voltage only by a qualified person who is aware of the hazard involved.

WARNING: If the mains plug has to be adapted to the local situation, such adaption should be done by a qualified person only.

Make sure that only fuses of the required current rating, and of the specified type, are used for renewal. The use of repaired fuses, and/or the short-circuiting of fuse holders, are prohibited.

The fuse shall be renewed only by a qualified person who is aware of the hazard involved.

WARNING: The instrument shall be disconnected from all voltage sources when a fuse is to be renewed, or when the instrument is to be adapted to a different mains voltage.

2.3. MAINS VOLTAGE SETTING AND FUSES

The safety instructions in chapter 2.2.4. must be followed.

On delivery from the factory the instrument is set to 220 V (PM 5134) resp. 110 V (PM 5134 M).

If the instrument is to be used on a different supply voltage proceed as follows:

- Unplug the mains connector
- Fold up the handle to the top.
For this push the buttons of the handle.
- Loosen the central screw at the rear
- Dismantle the cabinet
- Change the solder links
according to the connection diagram on the
bottom side of the instrument

fuse	110V 800 mAT	128V 800 mAT	220V 400 mAT	238V 400 mAT
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○

- If necessary exchange the supplied fuse and mains voltage label
- Close the instrument

2.4. OPERATING POSITION OF THE INSTRUMENT

The instrument may be used in the positions indicated in clause 1.2.13. With the handle folded down, the instrument may be used in a sloping position; for this push the buttons of the handle. The characteristics mentioned in Section 1.2. are guaranteed for the specified positions.

Ensure that the ventilation holes in the cover are free of obstruction.

Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.

2.5. DISMANTLING THE INSTRUMENT

- Unplug the mains connector
- Fold up the handle to the top. For this push the buttons of the handle
- Loosen the central screw at the rear
- Dismantle the cabinet

2.6. RADIO INTERFERENCE SUPPRESSION

Radio interference of the instrument is suppressed and checked carefully. In connection with deficient suppressed base units and further units radio interference can be generated, which have to be suppressed by means of additional activities.

3. OPERATING INSTRUCTIONS

3.1. CONTROLS AND SOCKETS (Fig. 31, 32, 37)

Legend	Position	Function
POWER	83	mains switch: white dot for ON position
○ ON ● OFF		
WAVE FORM	87	signal wave form, rotary switch
FREQ RANGE Hz	85	frequency ranges, rotary switch
FREQUENCY	START [STOP]	601/1-2 start frequency } for SWEEP mode; 602/1-2 stop frequency } double potentiometer 602/1-2 frequency adjustment for the other operating modes (MODE)
	409, 411	7-segment LED display
	412, 413	
AMPL/FREQ mHz, Hz, kHz, MHz	803/U2	measuring mode for the digital display , pushbutton
Vpp	357-360	indication of the frequency range, LEDs
ERROR	361	indication of amplitude measurement, LED
STOP, RUN, START	354-356	state of internal sweep, LED
DUTY CYCLE	82/2	duty cycle switch, pushbutton
	603	duty cycle control, potentiometer
ATTENUATION	802/1-4	fixed attenuation, pushbutton array
AMPLITUDE	608	variable attenuation, tandem potentiometer
DC OFFSET	604	DC offset, if pulled;
PUSH FOR ZERO		push-pull-switch with potentiometer
50 Ω/600 Ω	82/3	output impedance, pushbutton
OUTPUT	807	output connection, BNC connector at the front side
MODE	84	operating mode, rotary switch
X-TAL LOCK/TUNE	82/1	x-tal frequency control locked or free, pushbutton
MOD/SWEEP PERIOD s	86	period range for modulation or sweep mode, rotary switch
PERIOD	606	variable period, potentiometer
HOLD	81/1	sweep hold, pushbutton
RESET	81/2	sweep reset, pushbutton
STD BY/CONT	81/3	stand by/continuous operation, pushbutton
TRIG	81/4	trigger, pushbutton
AM/FM DEPTH	607	degree or depth of modulation, potentiometer
START PHASE	605	phase control for burst trigger or single pulse trigger, potentiometer
MODULATION	804	output modulation signals
TTL	805	output TTL signal
PEN LIFT	806	pen lift control signal
		BNC
		BNC
		BNC
		at the rear side

Legend		Position	Function	
SWEET/FM	INPUT	801	external sweep or FM signal	BNC
AM		802	external amplitude modulation	BNC
TRIG & BURST		803	external trigger	BNC

at the
rear side

3.2. OPERATION

3.2.1. Setting the wave form

The required wave form, sine, triangular, square wave, positive or negative pulses is selected by the WAVE FORM switch. If the duty cycle of the output signal shall be set to a value different to 50%, the pushbutton DUTY CYCLE must be pressed allowing the required value to be set by the DUTY CYCLE control. In the 20 MHz range this action is not possible being indicated by ERROR, see 3.2.7.

At the socket TTL OUTPUT a TTL signal is available, corresponding to the inverted signal at the OUTPUT socket.

3.2.2. Setting the frequency, see also short-form instruction 3.2.6.1.

The following elements serve for frequency adjustment:

- the FREQ RANGE switch, decadal stepped
- the continuously and independently operating STOP and START controls; double potmeters with different sensitivities for convenient operation
- the digital frequency and automatic dimension display
- the ERROR indicator for unallowed combinations of frequency and duty cycle settings

The stop frequency is adjusted in NORMAL mode by means of the STOP control with pre-set frequency range. In the same range with chosen SWEEP mode, the START control serves for adjusting the start frequency. The start frequency may be higher or lower than the stop frequency.

Note: In X-TAL or X-TAL AM mode the displayed frequency is used as reference value for the oscillator frequency. To avoid frequency hopping caused by least significant digit switching of the display, pushbutton X-TAL LOCK should be activated after setting the desired frequency.
If the modulation/sweep oscillator is not used, it should be switched off, switch to STD BY.
Further more, when pushbutton AMPL/FREQ is pressed, the last indicated value of the frequency is locked and there will be no change by turning the frequency potmeters.

3.2.3. Setting the OUTPUT voltage, see also short-form instruction 3.2.6.2.

The amplitude of the output signal is continuously adjustable by means of the AMPLITUDE control. With AMPL/FREQ button pressed, this value, p-p, is digitally displayed.

Pulled button DC OFFSET enables a continuously adjustable positive or negative d.c. voltage to be added to the output signal.

With WAVE FORM switch in position DC, the a.c. part of the output signal is switched off and the d.c. voltage only is fed to the output.

With step attenuator ATTENUATION, the output signal including the DC offset can be attenuated in any combinable steps of 3 dB, 6 dB, 10 dB and 20 dB.

With the $600\Omega/50\Omega$ pushbutton the required output impedance can be selected.

Note: The output amplifier could be overdriven due to adding signal and DC offset voltage. To avoid limiting, the peak value of the open-circuit output voltage must not exceed ± 10 V (step attenuator set to 0 dB).

3.2.4. Setting the internal sweep, see also short-form instruction 3.2.6.3.

During the SWEEP PERIOD a sweep within one frequency sub-range is linearly performed from the START to the STOP frequency.

The sweep period can be selected in sub-ranges and is fine adjustable.

Starting a single sweep is done by pressing the pushbutton TRIG or by a trigger pulse (H/L edge e.g. of a TTL signal) at the TRIG & BURST INPUT. Continuous sweep is realized by unlocking the pushbutton STD BY/CONT.

The MODULATION OUTPUT socket at the rear side provides the momentary sweep voltage corresponding to a distinct signal frequency for controlling an oscilloscope or x - y plotter. The voltage to frequency relationship is linear; a sweep voltage of 0 V represents f_{START} , a sweep voltage of +5 V f_{STOP} .

Further elements for manual control are

- the HOLD pushbutton to stop the sweep immediately
- the RESET pushbutton for resetting to f_{START} during the sweep.

Note: Before executing an internal sweep, disconnect all cables from the SWEEP INPUT socket. This input is not switched off during an internal sweep.

3.2.5. External sweep and frequency modulation, see also short-form instruction 3.2.6.3.

A voltage at the SWEEP/FM INPUT socket modulates the frequency of the generator. The required basic frequency is adjusted by means of the FREQ RANGE switch and the STOP control. The frequency varies proportionally to the d.c. or a.c. voltage at the socket.

The maximum frequency variation may not exceed 2 1/2 decades, whereby the actual upper frequency limit is also valid as sweep limit, which should not be overdriven because of signal distortion due to overdriving the current source.

3.2.6. BURST and SINGLE

After switching from STD BY to CONT BURST or CONT SINGLE the first period (repetition time) differs from the following. These following periods correspond to the adjusted time.

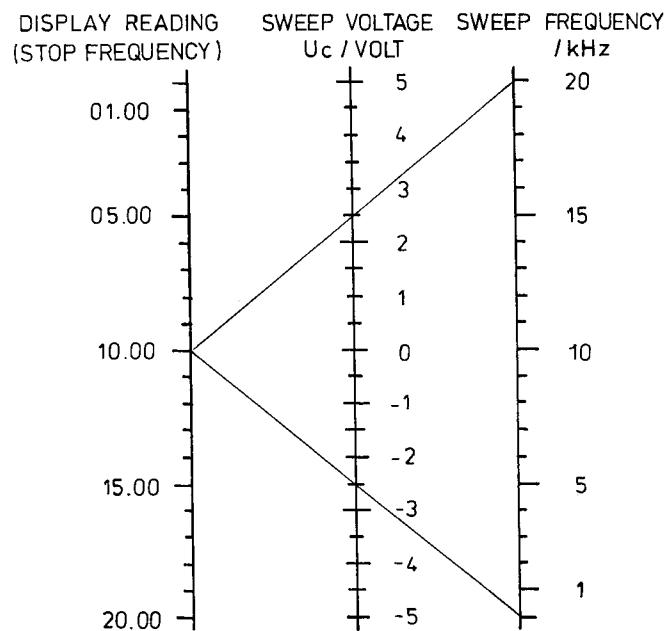


Fig. 1 External sweep;
sweep range vs. sweep control voltage U_c ;
example for range VII (1 kHz - 20 kHz)

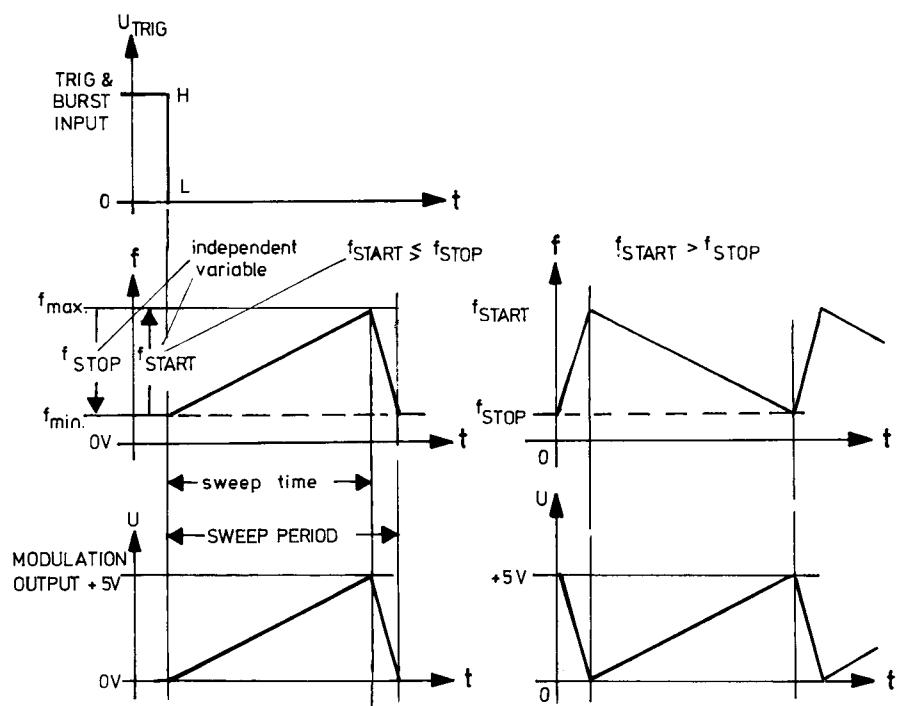
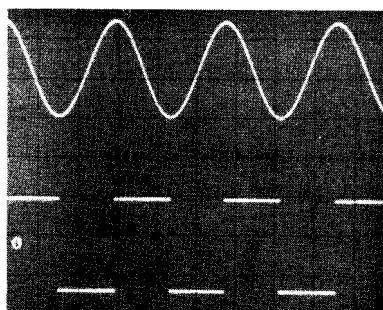
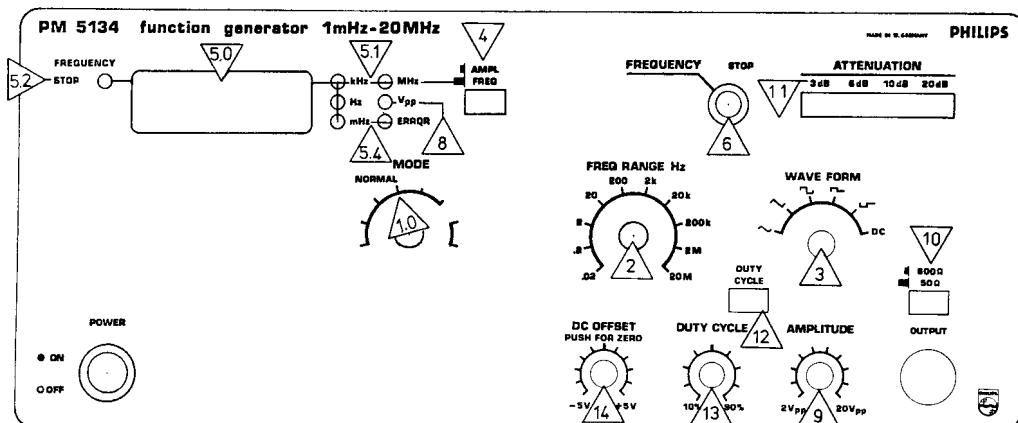
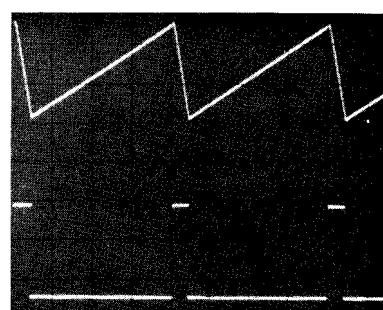


Fig. 2 Sweep mode



Sine wave output signal and corresponding
TTL signal



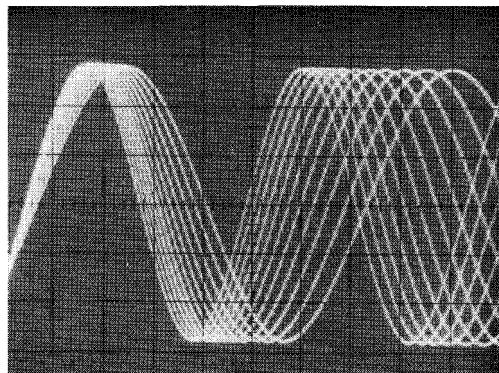
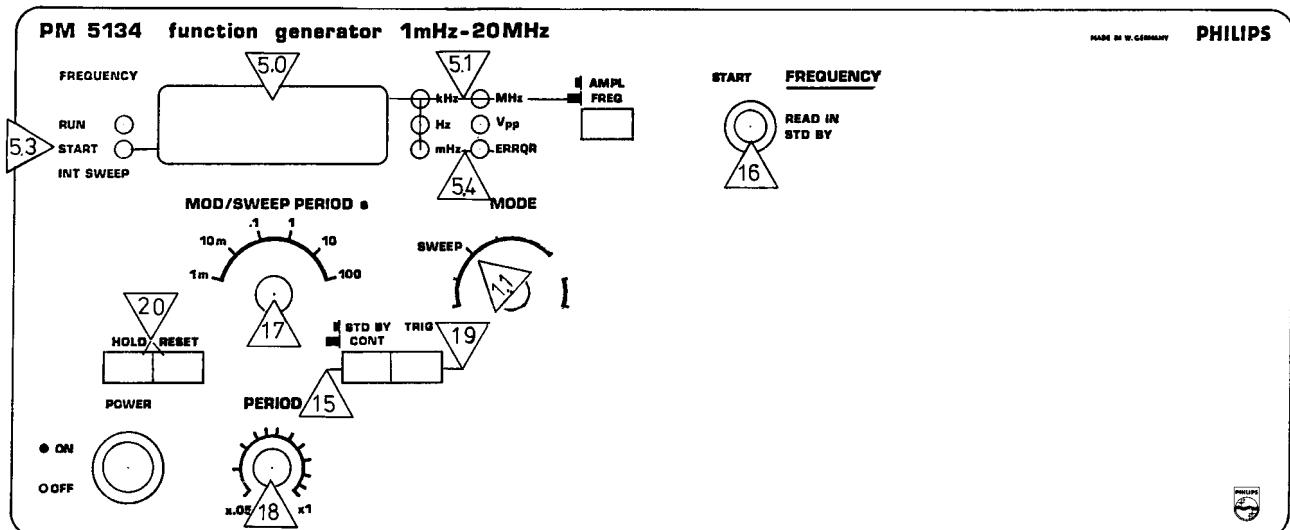
Variable duty cycle shown in triangular and
square wave signal

3.2.6.1. NORMAL mode

- 1.0 Set to NORMAL
- 2 select frequency range
- 3 choose signal wave form
- 4 if necessary, unlock AMPL/FREQ button
- 5.0 displayed frequency lies within the chosen frequency range
- 5.1 with respect to the indicated dimension
- 5.2 indication STOP lights
- 6 set (coarse/fine) the required frequency by means of the double control STOP

3.2.6.2. 4 push AMPL/FREQ button

- 8 Vpp indicates voltage measurement;
- 5.0 the display indicates the open circuit amplitude at the input of the attenuator
- 9 set AMPLITUDE to the required value
- 10 select output impedance
- 11 choose ATTENUATION
- 12 if required, push DUTY CYCLE button
- 13 adjust the duty cycle by means of the DUTY CYCLE control
- 5.4 ERROR indicator lights in the 20 MHz frequency range,
if DUTY CYCLE pushbutton is pressed
- 14 if required, pull switch DC OFFSET for adding a d.c. offset to the a.c. signal
and adjust the OFFSET by means of the control



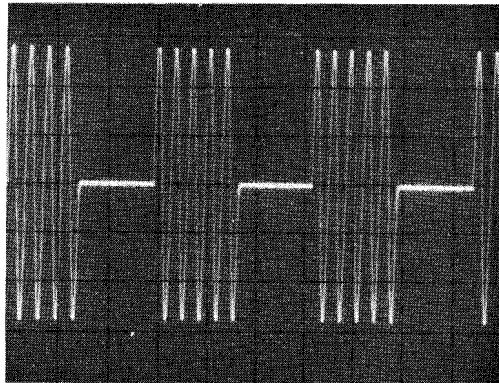
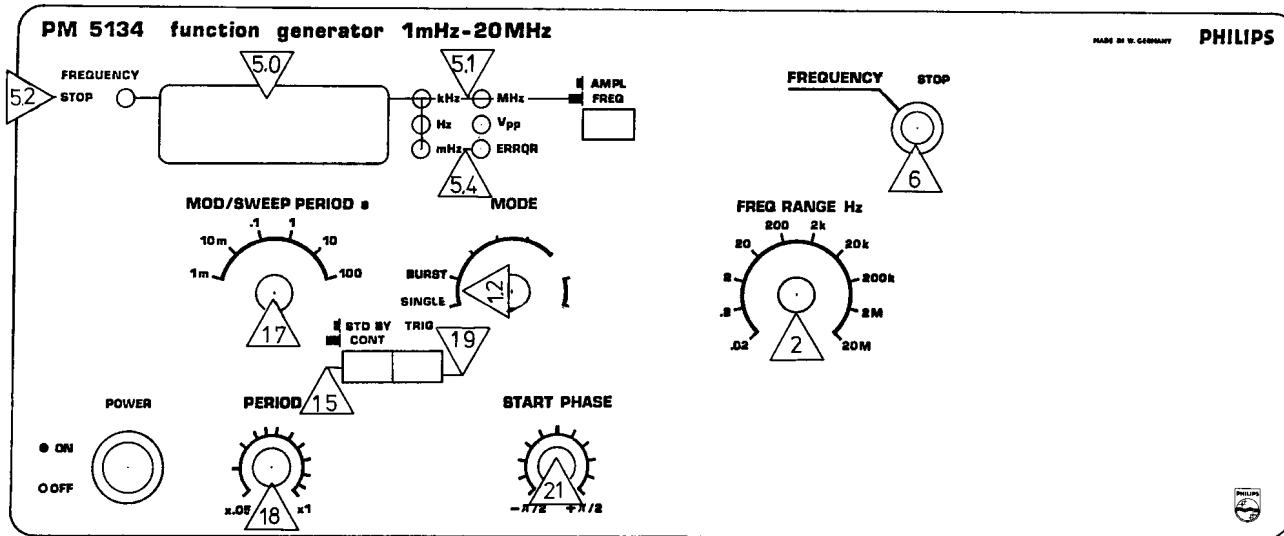
Oscillogram showing frequency sweep

3.2.6.3. SWEEP mode

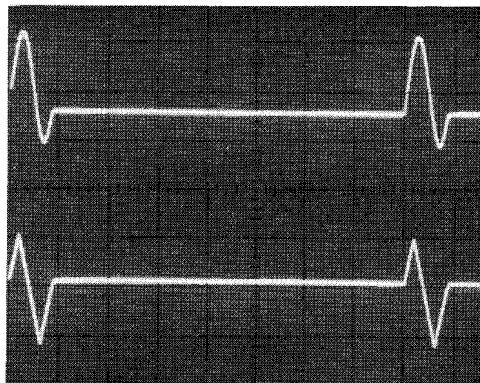
Adjust STOP frequency in NORMAL mode, see 3.2.6.1.

- 1.1 set to SWEEP
- 15 set sweep generator to STD BY
- 5.3 START frequency indication lights
- 16 adjust required start frequency by coarse/fine START control
- 17 choose SWEEP PERIOD range
- 5.4 ERROR indication for SWEEP PERIOD ranges 1 m, 10 m
- 18 adjust required period time with PERIOD control
- 15 start the sweep by unlocking the pushbutton or:
- 19 start by pushing the button or by external trigger signal
- 20 if required, HOLD or RESET the sweep

If necessary, check and correct the settings of the output signal according to 3.2.6.2.



Burst signal

Single facility shown with different start phase
between sine wave and triangular wave

3.2.6.4. BURST or SINGLE mode

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

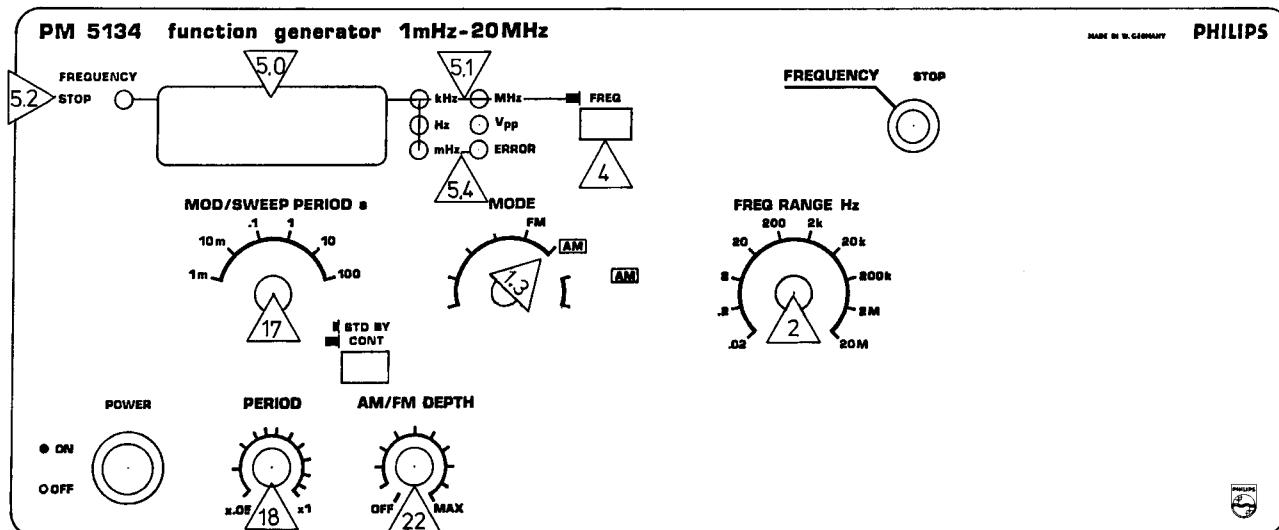
- 1.2 set to SINGLE or BURST
- 5.4 ERROR indication (flashing) for 20 MHz range
- 5.2 STOP frequency is indicated
- 17 choose range of repetition period or burst duration
- 18 adjust repetition period or burst duration
- 21 adjust start phase
- 15.2 start periodical operation by unlocking the pushbutton or:
- 19.1 start single operation by pushing the TRIG button or by external trigger signal

If necessary, check and correct the settings of the output signal according to 3.2.6.2.

3.2.6.4.1. External BURST

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

- 1.0 set to NORMAL
- 2 apply external square wave signal (TTL level) to socket TRIG & BURST (see 1.2.7.)
- 21 adjust start/stop phase

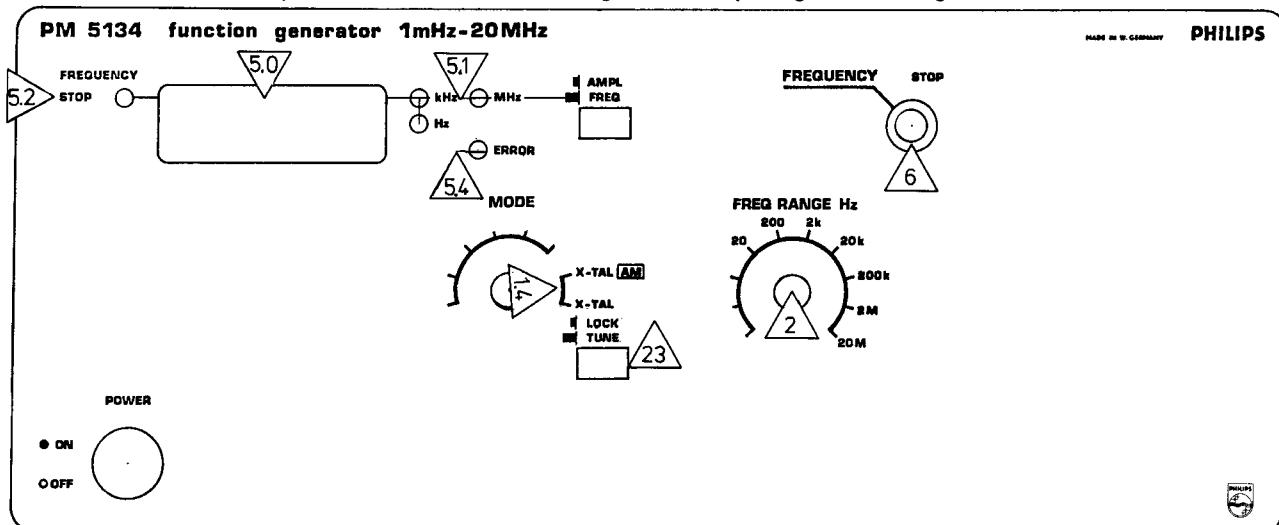


3.2.6.5. FM mode; AM or (X – TAL) AM

Adjust carrier frequency as STOP frequency in NORMAL mode, see 3.2.6.1.

- 1.3 set to FM or AM or X-TAL AM (if necessary unlock AMPL/FREQ pushbutton)
- 5.2 STOP frequency is indicated (if necessary, unlock STD BY pushbutton)
- 5.4 ERROR indication for X-TAL AM in ranges .02/.2/2 Hz or frequency settings < 0100
- 17 choose modulation frequency range
- 18 adjust modulation frequency
- 22 adjust AM factor or frequency deviation or set to OFF for external AM

If necessary, check and correct the settings of the output signal according to 3.2.6.2.



3.2.6.6. X-TAL or X-TAL (AM)

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

- 1.4 set to X-TAL or X-TAL AM
- 23 push LOCK/TUNE button and so freeze display and frequency
- 5.4 ERROR indication for positions 0.02/.2/2 Hz or frequency settings < 0100

3.2.7. Error indication

In order to have a quick indication of unallowed setting of frequencies, frequency ranges and duty cycle the LED indicator ERROR flashes. The unallowed combinations of settings are shown in the following table:

MODE	MOD/SWEEP PERIOD s	FREQ RANGE Hz	Display
SWEEP	1 ms; 10 ms		
SINGLE; BURST		20 MHz	
X-TAL; X-TAL AM		.02/.2/2 Hz	
X-TAL; X-TAL AM			<0100
DUTY CYCLE		20 MHz	

Please note: In X-TAL mode, when pushbutton AMPL/FREQ is pressed, the last indicated value of the frequency is locked and there will be no change by tuning the frequency potmeters.

3.2.8. Frequency indication at the upper range limits

The normal upper limit of the frequency ranges is indicated by 2000 on the display. Actually the display range is limited to 2048 due to the digital voltmeter component in the display circuitry.

Turning the frequency potmeters above 2048 does not effect the display.

Service part

4.1. CIRCUIT DESCRIPTION PM 5134

4.1.1. Modulation generator, see figs. 4.1 - 1 and 41

The modulation generator generates input voltages for the control section. In SWEEP mode sawtooth voltages (10 Vpp) and in BURST and SINGLE CYCLE mode square wave signals (5 Vpp) are generated. The modulation generator mainly consists of the integrator 219 with input FETs 146 and charging capacitors 431 - 435, comparator 151/152, current switch 148/149, regulator 144/145 and square wave switch 218. The potmeter PERIOD determines the square wave output voltage of OP 218 which is fed via range resistors 712 - 714 to the integrator.

The modulation generator is set to sweep mode by closing all 4 MOS- switches 222 controlled by transistors 157/158.

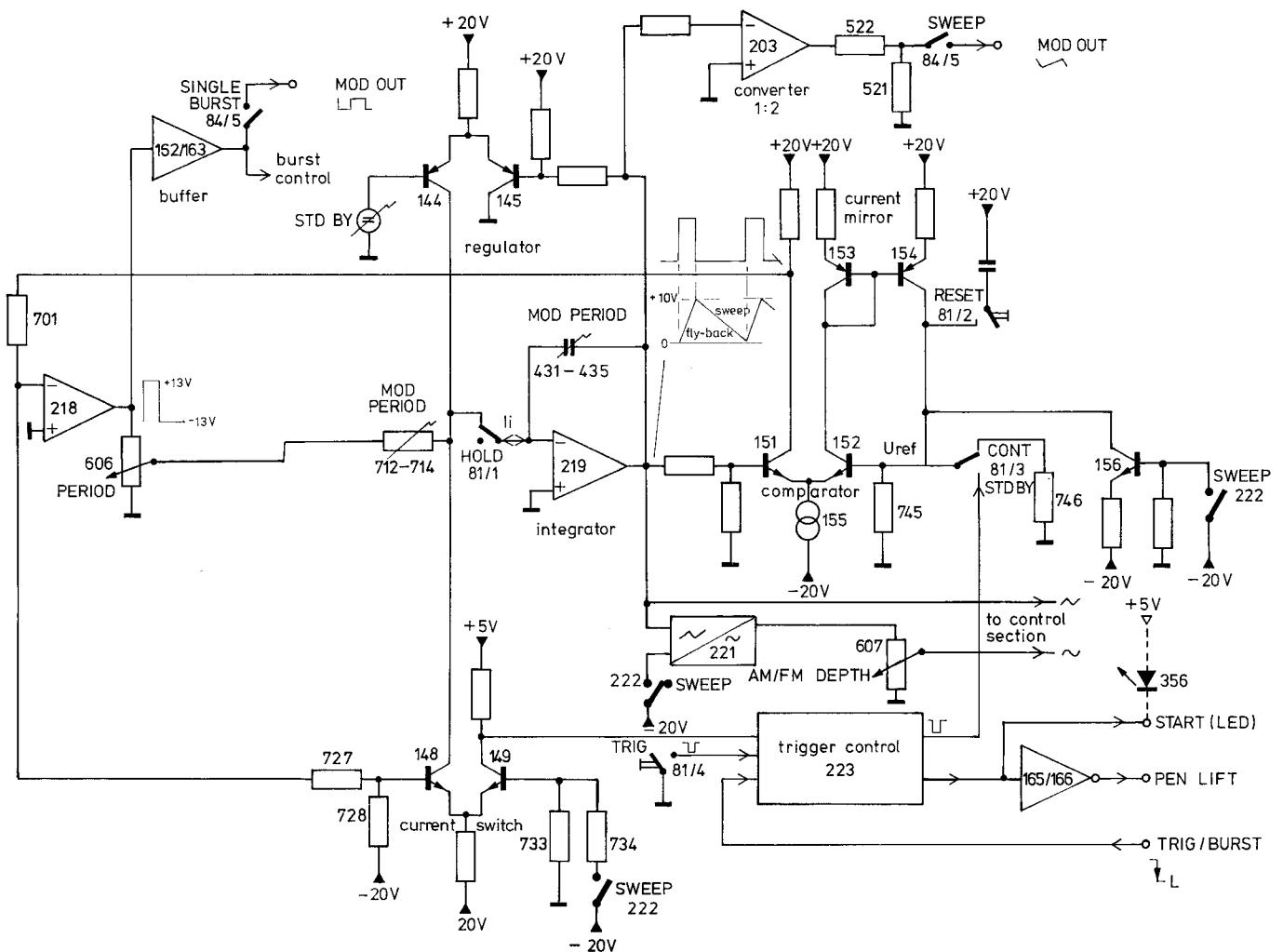


Fig. 4.1 - 1 Modulation generator

In continuous SWEEP mode a positive voltage is applied to the input of the integrator, resulting in a negative going ramp from 10 V to 0 V at the output of the integrator. The reference level Uref of the comparator at the base of transistor 152 is set to 0 V. When the integrator output voltage reaches 0 V, transistor 151 is turned off and transistor 148 is turned on. Simultaneously the collector current of transistor 155 is routed via transistor 152 and the current mirror 153/154 to resistors 745/746 establishing a reference voltage of about 4.8 V. In consequence of the high collector current of transistor 148 the integrator now quickly flies back to +10 V. At this level the comparator turns over to the initial state and a new cycle starts.

In **STAND BY** mode the positive reference level of comparator 151/152 during fly-back phase of the integrator is increased by switching off resistor 746 to 6 V. Hence the comparator 151/152 can't switch over, when the integrator output voltage arrives at 10 V. This integrator output level is now fixed by a regulator circuitry comprising 144/145. By switch 81/3 the -13 V output voltage of 218 is connected to 704, lowering the base voltage of 144 to about 15 V. When the integrator output voltage reaches 10 V the base voltage of 145 approaches 15 V too; so transistor 144 becomes conducting. The collector output current thus will balance the integrator input current 219. By this way the integrator output voltage is stabilized to 10 V.

When pressing pushbutton **TRIG** only one integrator sawtooth cycle is initiated. A negative pulse is applied to the reference input of comparator 151/152 via trigger control 223 and the comparator is switched over from its STAND BY position. Furthermore triggering is possible by an external TTL signal on the falling edge via input **TRIG & BURST**.

When pressing pushbutton **RESET** a positive pulse is fed to the reference input of the comparator, switching over the comparator and initiating fly-back.

In **HOLD** mode current to the integrator is switched off by SK 81/1 and the integrator remains at its instantaneous output voltage.

Indication of the sweep status is done by the LEDs RUN and START.

In **STAND BY** mode transistor 149 is switched off. Hence collector voltage is high. This high level is inverted to low by 223.2.3 and fed to the LED control circuitry 406, 417 and 420. Additionally, high level from mode switch 84 is applied to the LED control circuitry. Hence during stand-by and sweep the corresponding LEDs are activated. The output of gate 223.2 is additionally applied to inverting circuitry transistors 165/166 for PEN LIFT OUTPUT.

In **SWEEP** mode the integrator output voltage slope is inverted by amplifier 203, attenuated by resistor 521:522 to 5 Vpp and fed to the MODULATION OUTPUT socket.

In all modes except **SWEEP** the integrator generates symmetrical triangular wave forms (5 Vpp). This is achieved by FET switches 222 which are turned off. The output current of current source 155 is halved resulting in 2.5 Vpp instead of 4.8 Vpp for sweep mode at the comparator reference input. Additionally, current source 156 is switched on, hence the two reference voltages become symmetrical with respect to zero. Therefore the switch over function of the comparator is performed at ± 2.5 V integrator output voltage. Stand-by is inhibited as 148 is turned off and 144 can't be turned on by 145.

The integrator input current is derived from the saturation output levels 218, which are nearly symmetrical with respect to zero. Therefore a triangular integrator output voltage results. This voltage is applied to the **modulation sine shaper** comprising 159, 221 and 161. The distortion factor is set to minimum by potmeter 721, 769 and 772. The sine shaper output voltage is attenuated by the AM/FM DEPTH potmeter 607 and routed via 84/6 to the input amplifier 203 of the control section. Additionally, the sine wave voltage is applied to the MODULATION OUTPUT socket via SK 84/5.

4.1.2. Control section, see figs. 4.1 - 2, 41, 42

The general task of the control section is to generate charging currents for the main oscillator. Inputs of this circuitry are the wiper voltages of the start and stop frequency potmeter, the output voltage of the modulation generator and the external sweep or modulation signal. These voltages are converted into the output currents I_p and I_n . The conversion characteristic is linear.

In **NORMAL** mode the input of the amplifier 203 is set to ground; so the start potentiometer is not active. As the output of the amplifier is $U = 2 Ur - Usweep$, where $Ur = +5$ V, +10 V are applied to the potmeter 602 for the (stop) frequency setting. The voltages at the wipers are converted into currents via resistors 529 to 533 and summed up at the input of amplifier 205. This current is transferred by transistor 102 to 536, 537 establishing the control voltage U_c for the following voltage to current converters.

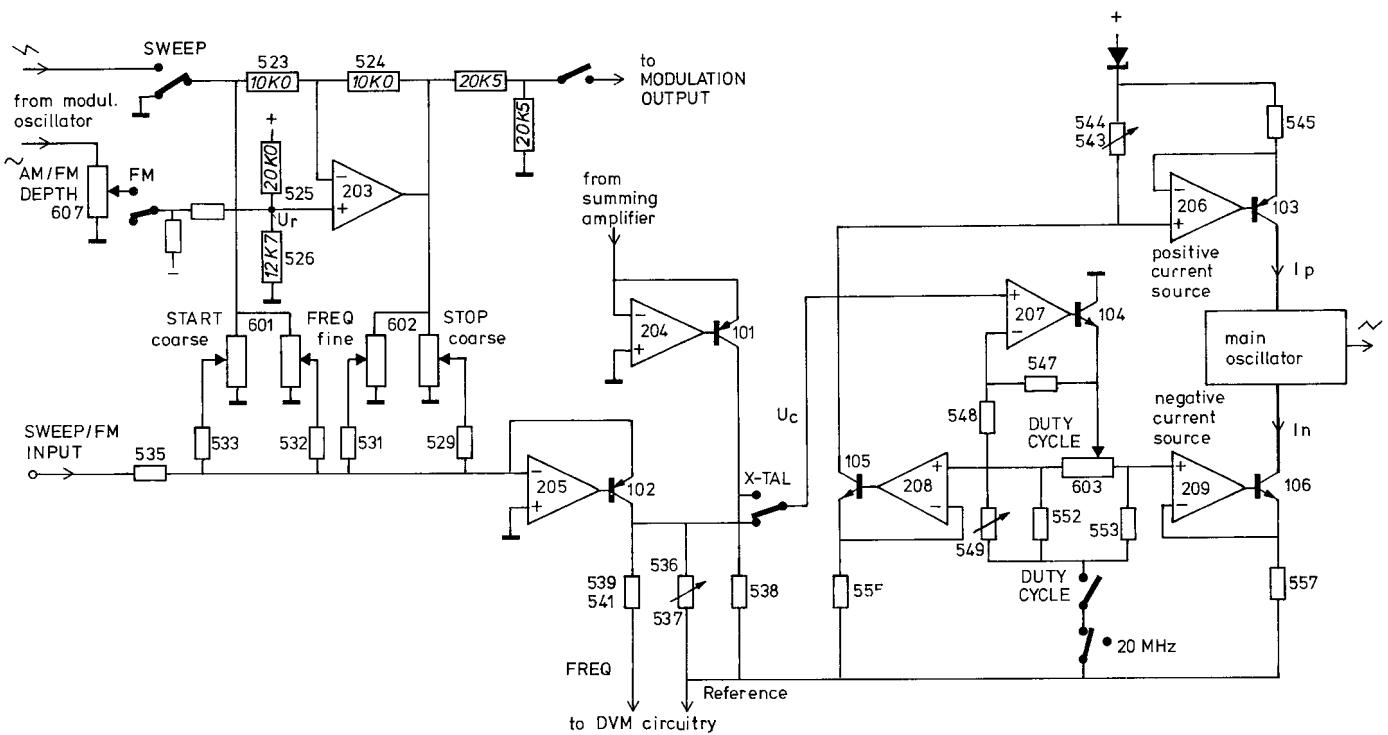


Fig. 4.1 - 2 Control section

When DUTY CYCLE is not pressed potmeter 603 is not active. Control voltage U_c is passed 1 : 1 via impedance converter OP 207/transistor 104 to the negative current source, comprising amplifier 209 and transistor 106 and to the auxiliary current source 208/105. The output current of 208/105 is fed to resistor 543/544, establishing a control voltage for the positive current source 206/103. The output current I_p is identical with I_n . Current range is from 0.5 mA to 10 mA in each frequency subrange.

In order to vary the duty cycle of the main oscillator signal the ratio I_p/I_n must be altered. Additionally the condition $1/I_p + 1/I_n = \text{constant}$ must be satisfied to get no frequency change. For the total setting range of the duty cycle each current (I_p, I_n resp.) is varied from 0.56 I to 5I where $I = I_p = I_n$ for normal mode or 50 % duty cycle respectively.

Variation of I_p/I_n is controlled by potmeter 603 when the DUTY CYCLE button is pressed. In this situation U_c is amplified by the amplifier 207 and divider 547 - 549. The output voltage 5 U_c is applied to potmeter wiper 603. In central position of 603 this voltage is decreased to U_c again by divider 603, 552 or 603, 553 respectively and applied to the current converter 209/106 and 208/105 resulting in $I_p = I_n = I$. In the end positions of 603 the resulting control voltages of the current converters are 0.56 U_c and 5 U_c , vice versa. The corresponding output currents are $I_p = 0.56 I$ and $I_n = 5 I$, vice versa. In the 20 MHz range the duty cycle function is switched off.

In SWEEP mode, stand-by state, +10 V output from the modulation oscillator is applied to amplifier 203 and to start potentiometer 601. Hence 0 V at the amplifier output and stop potmeter 602 is resulting. Thus 602 is inactive. During the sweep the modulation oscillator voltage represents a negative going ramp. Hence the voltages at the potmeters 601/602 are mutually decreasing and increasing until at the end of the sweep 602 is active only in normal mode, thus defining the stop frequency.

In the FM mode a sine wave voltage is added to U_p resulting in a superimposed sine wave voltage on 10 V d.c. at potmeter 602. Thus I_p and I_n of the control section get sinusoidal portions modulating the main oscillator frequency.

4.1.3. Main generator, see figs. 4.1 - 3, 42, 43

The main oscillator generates a symmetrical triangular voltage of 5 Vpp. It operates on the relaxation oscillator principle whereby a capacitor is first linearly charged in one direction and then linearly charged in the reverse direction. The frequency is determined by the selected range capacitor and the charging current, generated by the control section.

Switchover of the charging current is achieved by a transistor switching circuit controlled by a two-level detector or comparator at two predetermined voltage levels of the integrating capacitors.

The circuit operates as follows:

Assume that point 'a' is positive. The integration capacitor will charge via transistor 111 and 112 (109 and 113 are switched off). At a predetermined level, transistor 124 of the comparator will switch on. So transistors 123, 125 and 121 are cut off, resulting in a negative reference voltage of the comparator at resistor 615 and in no load current I_a . The quadruple switch circuit will switch over. The capacitor will now be charged in the reverse direction via transistors 109 and 113. At a negative predetermined level, transistor 124 will switch off and open transistors 123, 125 and 121 again. So point 'a' is positive again and a new cycle starts. In this way, a triangular wave is generated, the frequency of which depends on the charging capacitor, the charging current and the signal amplitude.

The basic part of the oscillator is the quadruple switch with the frequency determining capacitors, selected by the front-panel pushbuttons FREQ RANGE Hz. Under the control of the square wave signal at point 'a', at each half-cycle two diagonal opposite transistors open while the other two close (i.e. 111, 112 open, 109, 113 close, vice versa). In this way the direction of the charging current is alternating.

The **main oscillator** generates a time-symmetrical output voltage. For 50 % duty cycle signals of the generator the charging currents I_p and I_n must be equal. Asymmetrical wave forms are generated, if these charging currents are differing. This is dependant from the duty cycle settings. The symmetry of the triangular output voltage with respect to zero is resulting from switch over voltages of the comparator 124/125. The loading currents I_p/I_n vary between 0.5 mA and 10 mA for all ranges.

For the 20 MHz range the integration capacitors 373 and 392 are active only. For the ranges 2 MHz – 200 Hz capacitors 393 – 403 are switched in. In order to reduce the value and so the size of the capacitors for the 4 lowest frequency ranges (20 mHz – 20 Hz) the capacitors are substituted by an **active integration** circuitry comprising OP 213/214 and capacitors 404 – 407. By this circuitry the effective capacity is 10^4 times higher than the integrator capacity. Adjustment is done by potmeter 629, 631, 632.

A high impedance FET buffer 115 avoids charging current leakage at the charging capacitor. Emitter followers 117/118 then connect the signal to the comparator.

To compensate for non-linearity in the frequency response in the higher ranges due to delays in the oscillator loop a **lead circuit** is inserted between oscillator and comparator, whereby 384/385 mainly in the 20 MHz range, 612/387 in the 2 MHz range and 611/386 mainly in the 200 KHz range are active.

The **comparator** 124/125 compares the instantaneous value of the capacitor charging potential against the reference level at the base 125 which is $U_r = \pm 0.27$ V representing symmetrical square wave. When the base 124 attains one of the reference levels, the comparator actuates the quadruple switch. At the same time, the comparator reference level is switched to the opposite polarity.

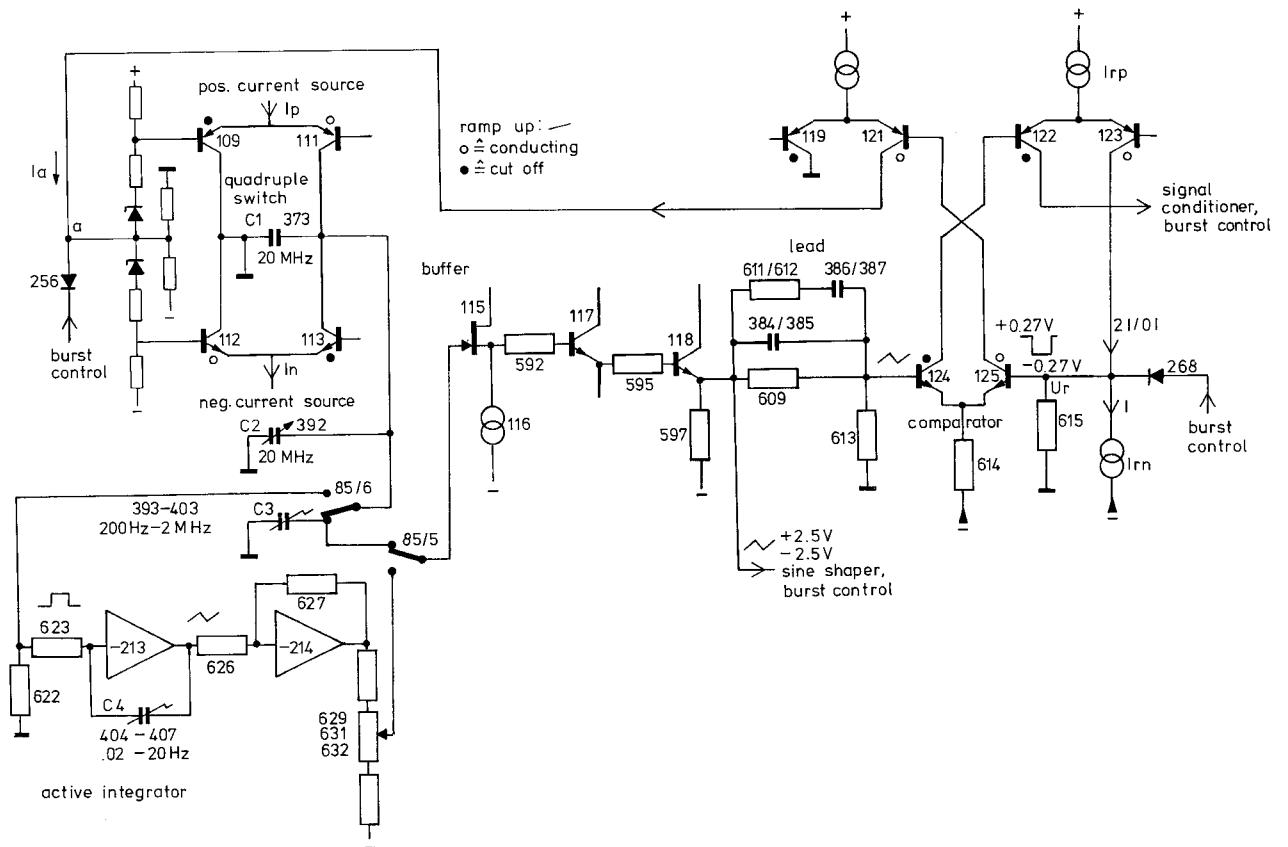


Fig. 4.1 - 3 Main oscillator

On the reference side of the comparator two current sources I_{rp} and I_{rn} generate voltages at resistor 615. I_{rp} has twice the value of I_{rn} . According to the state of transistor 123 either the difference of the two sources results in a +0.27 V reference level or the second source alone generates -0.27 V reference level.

The triangular signal of the oscillator is fed via WAVE FORM switch to the sine shaper circuit. First the peaks of the triangular wave are suppressed by the diodes 311, 312. Then the conversion to sine wave is achieved by a wave form shaping diode-resistor network. Preset controls for minimum distortion are potentiometers 832, 836; 826, 829. The output is routed via a low-pass filter which serves to reduce the harmonic content of the sine wave at the highest frequencies. Preset 844 provides a control adjustment for the amplitude response. The output d.c. offset is set to zero by 840.

The square wave generator provides three wave forms, i.e. square wave, positive and negative pulse. The rectangular signal at gate 215 in the signal conditioner controls the square wave generator which comprises two symmetrical current sources 136/137 and 138/139. Positive or negative pulses are performed by switching off one of the two sources. In sine wave, triangle and DC mode the square wave generator is switched off via line 'f'.

The four buffers with transistors 128/129, 179/181, 182/183 and 141/142 serve for decoupling the concerning circuitries and for driving the relative low ohmic loads and the various nodes.

4.1.4. Burst control, see figs. 4. 1 - 4, 41, 42

The burst function of the main oscillator is controlled by the TTL signal at inputs 216.1.2. When this input is high the oscillator is running free. After a high to low transition of this input the oscillator is completing the last triangular wave cycle on the positive going ramp until the start/stop level is reached.

In NORMAL mode the input control voltage is derived from the TRIG & BURST input socket. Without signal source connected to this input resistor 654 sets 216.1.2 to high; so the main oscillator runs free.

In BURST mode the TTL output voltage of the modulation generator is applied as control voltage. At the low to high transition 216.3 goes low. Therefore 216.10.11. are going high. By this action collector 132 is pulled up to ca. 1.0 V resulting in a reverse voltage at diode 256 in the main oscillator circuitry, thereby releasing the control input of the quadruple switch 109 - 113. Furthermore 216.8 is set to low reversing diode 277/268, thereby releasing comparator 124/125. The main oscillator starts running. When the control voltage at 216.2 is transitioning to low level, pins 216.3.4.12 are going high. By the next positive triggering pulse to 216.5 output 216.6 shortly goes low switching over flip-flop 216.8 - 13. By this action diodes 277/268 are turned on clamping the comparator reference input of the main oscillator to about 1.7 V. Furthermore diodes 275/276 are reversed. When the base voltage of transistor 132 derived from the main oscillator triangular output via buffer stage 128/129 attains the reference voltage at the base of 131, the collector of 132 starts conducting. This current increases until the collector current of 121 is nearly balanced. In this state the control voltage of the quadruple switch at resistor 577 is about 0 V. Now by the regulating function of 131/132 the collector currents of the transistor 113/111 exactly are balanced so that the main oscillator output voltage at emitter 118 is hold at a fixed level. This level can be adjusted by the START PHASE potmeter 605. The described burst function is periodically repeated by the control voltage at 216.2, which is derived from the modulation generator.

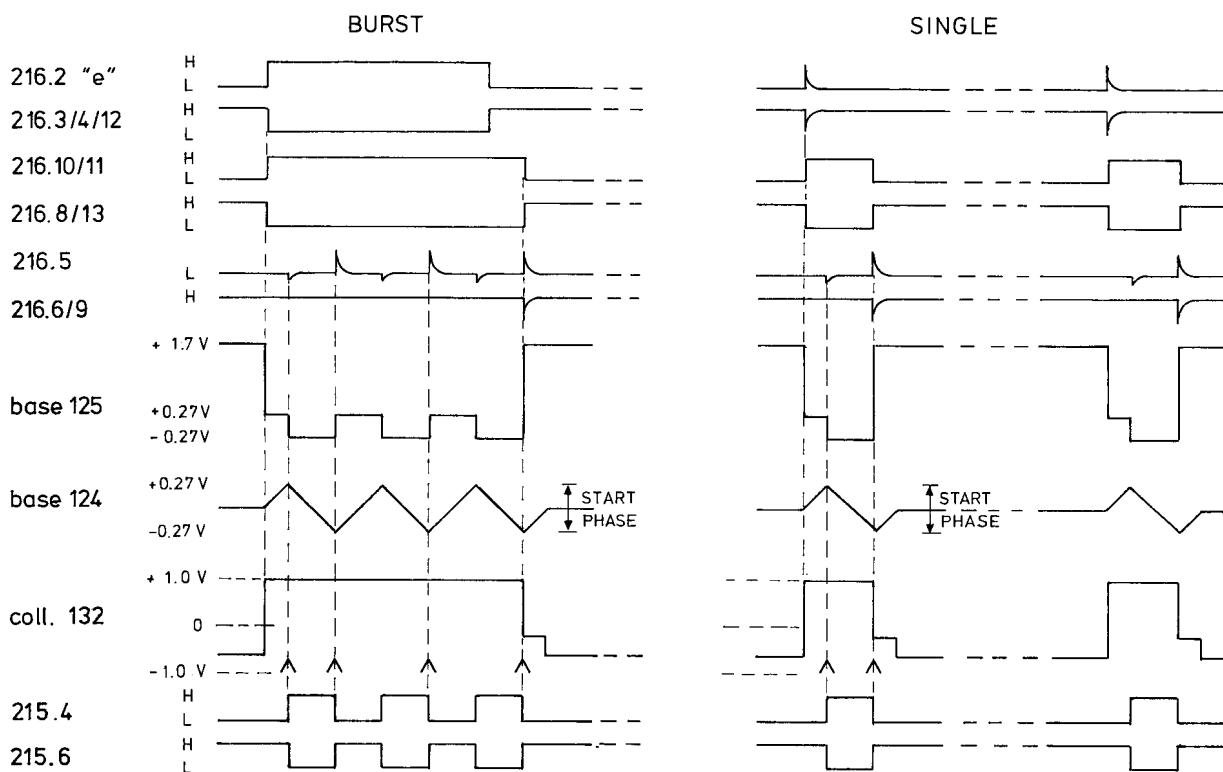


Fig. 4.1 - 4 Timing diagrams for BURST and SINGLE

In SINGLE mode positive trigger pulses are derived from the TTL output signal of the modulation generator at the positive going transitions. This is performed by lead circuit 443, 798. As 216.2 immediately goes low after the trigger pulse, flip-flop 216.8 - 13 is reset by the next trigger pulse to 216.5 derived from the high transition of 215.6. Thus the regulator 131/132 becomes active at the end of one main oscillator cycle. This means that only one oscillator cycle is performed with each trigger pulse to 216.2.

In the 20 MHz range BURST and SINGLE modes are inhibited by transistor 133 which is turned on by 85/1 setting 216.12 to low.

4.1.5. Amplitude modulator

The carrier input voltage of the differential stage 185/186 is derived from the sine shaper. The modulating voltage is applied to the differential stage 189/191. The modulating differential transistor stage consists of the two array transistors 184.1 - 5. The transconductance (mA/V) of this stage is controlled by the collector current of 189 comprising the modulating a.c. portion. In this way the differential output voltage of the modulating stage is the amplitude modulated carrier. Array transistors 184.6 - 11 serve for improving the linearity of the modulator. By trimming potmeter 863 the carrier amplitude can be adjusted. Setting the potmeter 866 defines the AM envelope symmetry. The differential output voltage of the modulator stage is amplified by a differential amplifier comprising transistors 193 - 198. The DC offset of the AM signal is adjusted to 0 V by potmeter 887.

4.1.6. Digital voltmeter circuitry, display

For digital frequency display the internal voltage U_c of the control section (see fig. 4.1 - 2) is routed via resistor 539/541, switch 803 and the instrumentation amplifier (see fig. 4.1 - 5) to the digital voltmeter (DVM) circuitry, where it is converted to digital and indicated by the 7-segment display. The generator output frequency is proportional to the control voltage U_c . The conversion offers the opportunity to indicate high frequencies as well as low frequencies down to 1 mHz immediately. The control voltage U_c varies between 50 mV and 1 V and is amplified by the differential amplifier 401, 402, 403 to $V_i = -4 U_c$.

For amplitude display a d.c. voltage is generated by the tandem section 608/1 of the amplitude potmeter 608 following proportionally the a.c. output amplitude of section 608/2. This d.c. voltage is applied to the amplitude display conditioner, the voltage follower 211/1 and routed via switches 84/1, 87/1, 803 and the instrumentation amplifier to the DVM circuitry. Additionally LEDs 354 - 360 are switched off by switch 803 and LED 361 'Vpp' becomes active.

For pulse wave forms the d.c. output voltage of the ampl. display conditioner is halved by resistors 571/572. In addition the output voltage is halved for AM by resistor 564.

The d.c. output voltage of the instrumentation amplifier is converted to digital by the **DVM circuitry** and transferred to the 7-segment display. In this circuitry OP 404/1 generates a stable reference voltage of $V_{ref} = +4.0$ V. The integrator is represented by OP 404/2 with capacitor 504. This integrator circuit is fed by currents I_i from the instrumentation amplifier and from the chopper output of DVM 405.3. The chopper output of 405 is switching between $+V_{ref}$ and 0 V. This switching function is controlled internally by the DVM 405 depending on the momentary integrator output voltage at pin 1. The resulting integrator output voltage generally is a sawtooth voltage. For small input voltages V_i (frequency or amplitude resp.) the integrator output voltage nearly becomes a symmetrical triangular wave.

In the **DVM** the sample frequency f_s is derived from the clock frequency divided by 16. The sample pulses are counted by an internal up/down counter during fixed periods controlled by an internal timer. The up/down counting function depends on the momentary positive or negative going slope of the integrator output voltage. After the up/down counting period the counter state represents the digitalized input voltage. The contents of the counter is transferred to a buffer memory and multiplexed to the display via decoder driver 408. The counter of the DVM 405 is reset and a new conversion cycle is started again.

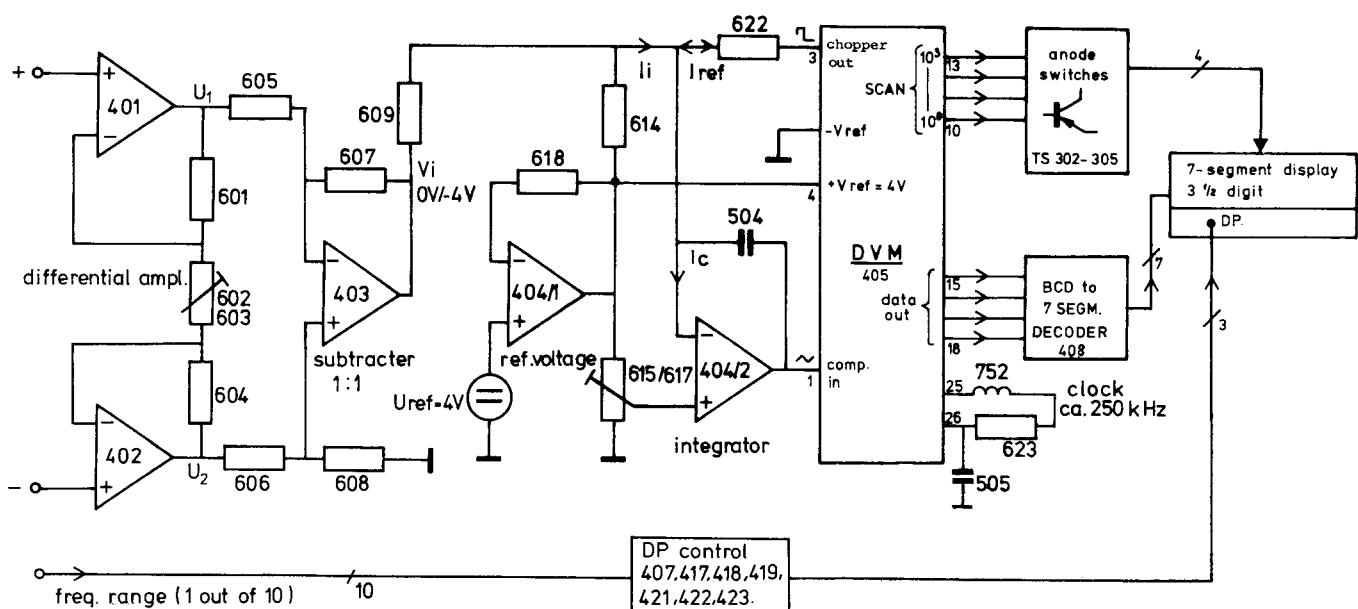


Fig. 4.1 - 5 DVM circuitry, display

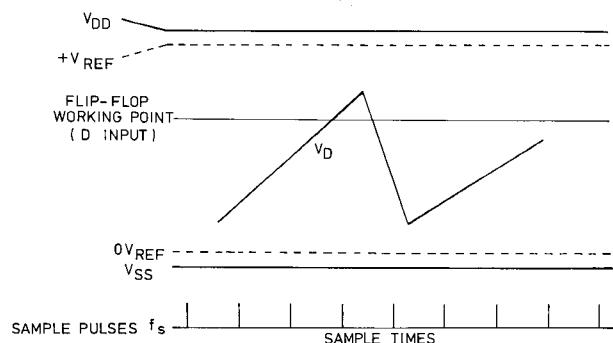
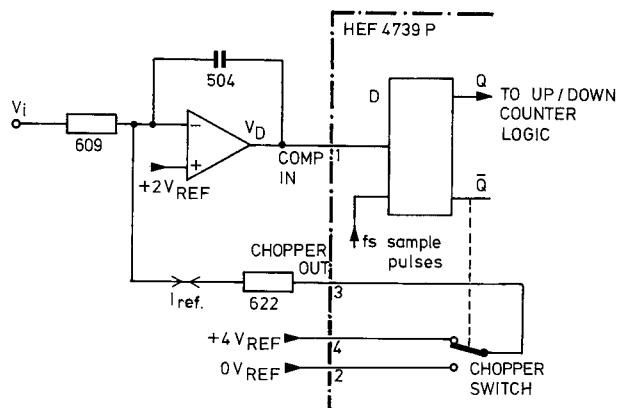


Fig. 4.1 - 6 Principle of delta-pulse modulation

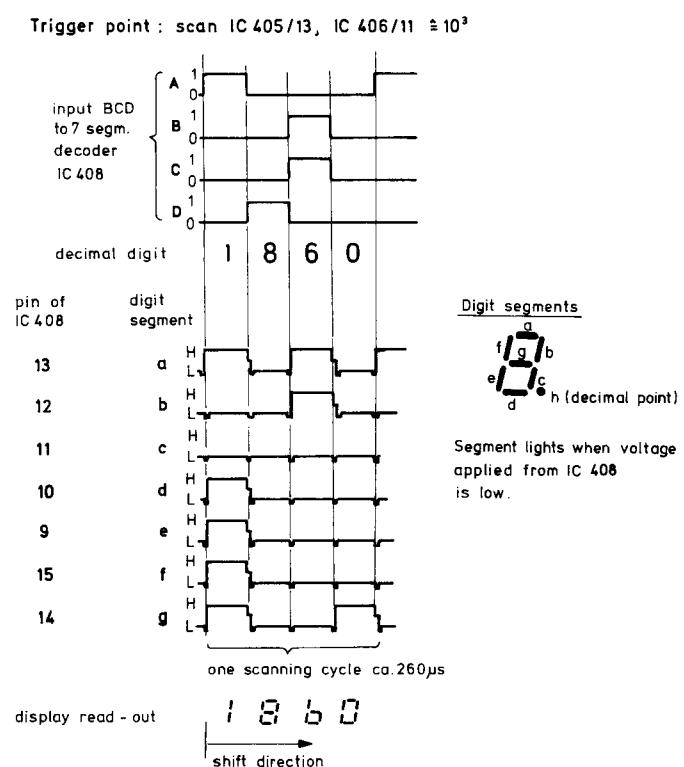


Fig. 4.1 - 7 Timing diagram of display presentation

4.1.7. Digital voltmeter circuit

Details

The ADC HEF 4739 P is based on the principle of delta-pulse modulation. This integrating system ensures good linearity and series mode rejection. In addition, the circuit contains a minimum of critical elements, the accuracy of the ADC being dependent only on the accuracy of the reference voltages. The output of flip-flop FF operates a chopper switch to connect the negative input of the integrator via R to either a positive or a negative reference voltage. The state of the flip-flop depends on the level of the D input at the time of a sample pulse f_s . In turn, the level of the D input depends on the state of charge of capacitor C. See fig. 4.1 - 6.

Assume that, at the instant of a pulse f_s , the voltage level at D is below the flip-flop working point. This results in a low output from the chopper and a negative reference voltage is connected to R. The input voltage V_i and the reference V_{ref} are both applied to the integrator/comparator. Because V_{ref} is greater than V_i within the scale range, the integrator output voltage increases and is given by:

$$V_{Dc} = \frac{1}{RC} (V_i - V_{ref}) t_c \quad (1) \quad \text{where } t_c \text{ is the charging time.}$$

At each succeeding sample pulse f_s , V_D is sampled and when V_D exceeds the flip-flop working point the flip-flop changes its state.

The integrator is then connected to the $+V_{ref}$, its output falls and is given by:

$$V_{Dd} = \frac{1}{RC} (V_i + V_{ref}) t_d \quad (2) \quad \text{where } t_d \text{ is the discharge time.}$$

It is seen that providing V_i is greater than 0 the slope resulting from equation (2) is greater than that resulting from equation (1). Since V_{ref} is greater than V_i , these equations show that the sign of the slope changes when the chopper is switched. Thus the integrator output is a sawtooth waveform.

From the equations, it can also be deduced that for a negative input the slopes are reversed; i.e. the positive slope becomes the faster. The digitised feedback limits the charge in the capacitor C so that a charge balance is obtained between the input voltage and the reference voltage. From the compensation method the average value V_D ($V_{Dc} + V_{Dd}$) will be equal to V_i .

Consequently:

$$V_i = \frac{t_c - t_d}{t_c + t_d} V_{ref} \quad (3) \quad \text{where } t_c + t_d = t_m \text{ (measuring time).}$$

Assuming:

$$\begin{aligned} N &= \text{total number of pulses } f_s \text{ during } t_m \\ n &= \text{total number of pulses } f_s \text{ during } t_c \end{aligned}$$

Then equation (3) can be written as:

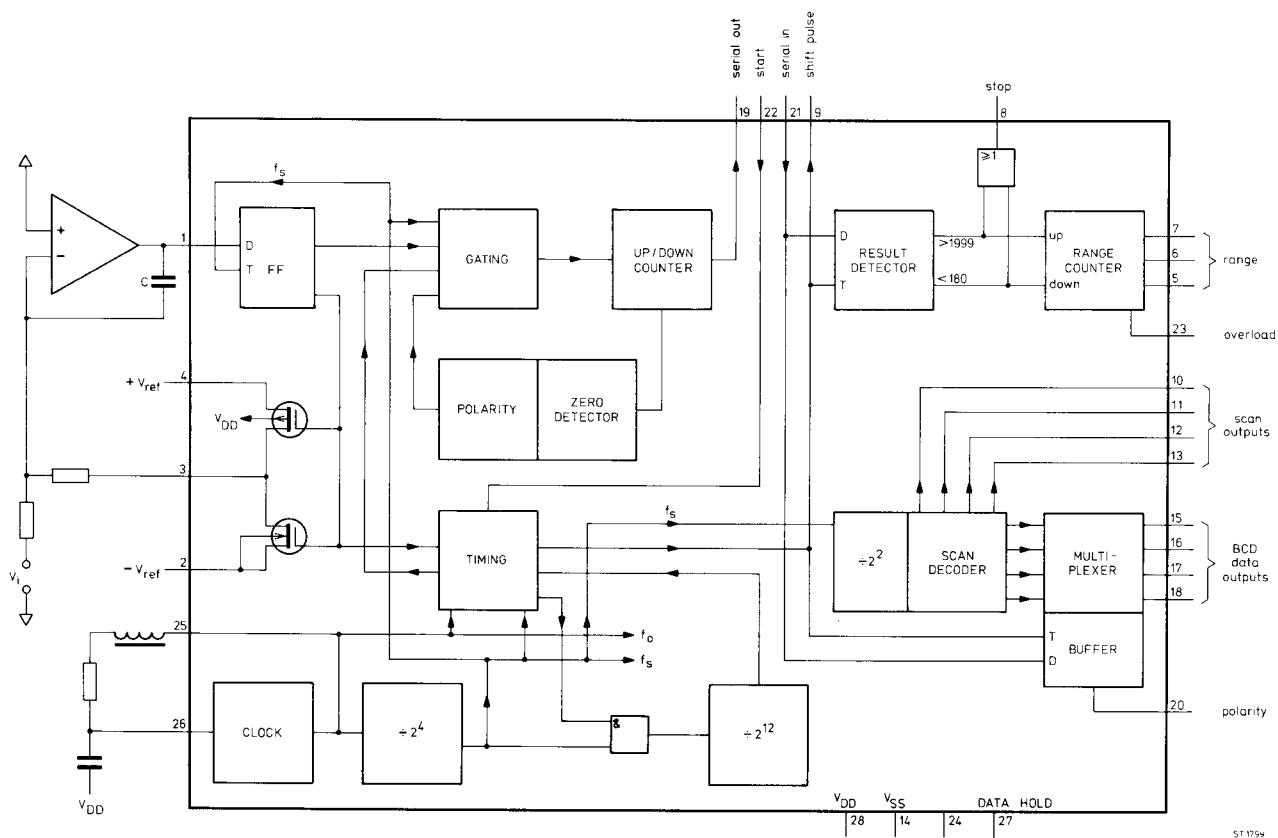
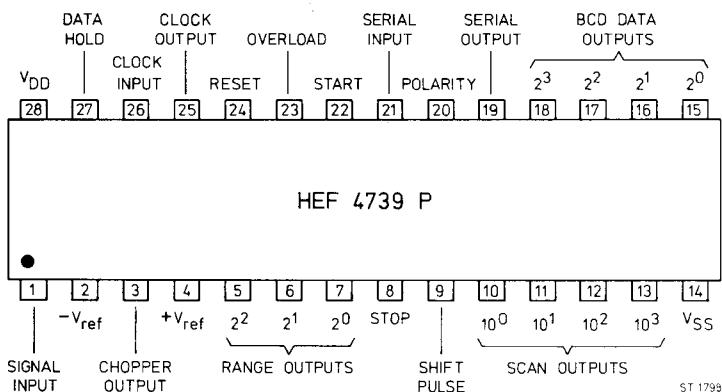
$$V_i = \frac{n - (N-n)}{N} V_{ref} \quad V_i = \frac{2n - N}{N} V_{ref} \quad (4)$$

Since an up/down counter is used to count up when $+V_{ref}$ is connected to the integrator, after N sample times the contents of the counter will be $2n - N$.

This counter includes polarity and zero detecting sections and counts the absolute value of $2n - N$ by shifting the counter contents at clock rate through an adder circuit that adds one binary up or down according to the state of Q and the polarity. At the end of the measuring period, the counter content (together with polarity) is serial-shifted out, at clock rate f_o , at pin 19 in synchronism with the shift pulses at pin 9. The serial data is organized as follows in NBCD code.

most significant bit = last bit out least significant bit = first bit out

bit no.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
data	POL	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	X
	10^3			10^2				10				1				



In the integrated circuit is $N = 4096$ and $+V_{ref} = +4 V$, $-V_{ref} = 0 V$. The figure shows the internal functions of the block. To obtain a stable display, the contents are divided by two and transferred into a memory, after which the counter is reset. A new measurement can start. Within the circuit block a multiplexer alternately connects each decade of the memory to the decoder driver. At the same time, a pulse is generated to drive the anode switch of the associated 7-segment "LED". The decoded information is then transferred via the decoder driver to the indicator "LED's", the cathodes of which are connected in parallel.

4.1.8. LED and decimal point control

LEDs 357 – 360 indicating the selected frequency range are controlled by switch 85/1 (code: 1 out of 10) and **range control logic** 406, 417, 419 – 421, 424.

Error indication for unallowed combinations of settings (see 3.2.7) is done by LED 362. The error control logic 415 - 417, 424, 449, 451 releases multivibrator 418 and LED 362 starts flashing at a rate of ca. 5 Hz.

Frequency displays < 0100 are monitored by 451, 449, 417. The output at 417.10 is applied to the error control logic activating LED 362 by the multivibrator.

The **decimal point (DP)** of the 3 1/2 digit display 409, 411 – 413 is set by the chosen frequency range by switch 85/1 and DP control logic 407, 417 – 419, 421 – 423.

Check display indication and range LEDs following the table check and adjustments, chapter 4.3.4. seq. 3.4. – 3.19.

Examples for DP- and RANGE-logic

FREQ. RANGE	TERMINAL/LEVEL							
20 mHz	IC 422 .9.10.11.12.13	IC 419 .1.2.3.11.12.13	IC 423 .9.10	IC 424 .5.6.12.13	IC 407 .3.4	IC 412 .6	LED 359	
	L L L H H	H L H H H L	H H	H L L H	H L	L	active	
2 MHz	IC 419 .8.9.10	IC 421 .1.2.8.9	IC 424 .8.9.12.13	IC 417 .5.6	IC 418 .4.5.6	IC 423 .14.15	IC 407 .1.2	IC 411 .6
	H L H	L L H H	L H L H	H L	H L L	H H	H L	360

Check ERROR indication LED 362 following the table check and adjustments chapter 4.3.4. seq. 10.2 - 10.5. and chapter 3.2.7.

Examples for ERROR-logic

MODE	TERMINAL/LEVEL							
SINGLE/ BURST 20 MHz	IC 415 .8.9.10	IC 416 .3.4.5.6.10.11.12.13	IC 417 .8.9	IC 418 .8.9.10	IC 424 .1.2	LED 362		
	H H H	L L H H H H L L	L H	L <u>U</u> <u>U</u>	<u>U</u> <u>U</u>	flash		
X-TAL/ AM < 0100	IC 451 .3.4.5.6.10.11.12.13	IC 449 .11.12.13	IC 416 .1.2.3.4.5.6.8.9	IC 415 .4.5.6	IC 417 .8.9.10.11	IC 418 .8.9.10	IC 424 .1.2	LED 362
	L L L H H L L L	L H H	L L H L L H H H	H H H	L H H L	L <u>U</u> <u>U</u>	<u>U</u> <u>U</u>	flash

4.1.9. X-TAL control

The operating principle of the x-tal control is presented in chapter 1.4. In the following part some additional details are given.

The task of the **memory/U2** is to store the displayed frequency number. The input data is derived from the serial output of the DVM 405.19. This data is fed via gates 442 to the input 2 of the shift register 443 serialized by shift register 444. The 16 bits data blocks of the DVM are clocked into the shift registers by the shift pulse at output 9. After each data block a strobe pulse generated by the mono-flop 445 transfers the parallel outputs of the shift registers into the 8 storage registers of 443/444 representing the data memory.

When the **X-TAL LOCK** button is pressed logic H-level is applied to pin 13 of 445 inhibiting the strobe function. Thus the storage register contents are frozen. Furthermore the serial output data of the shift registers 443/444 are repeatedly transferred via gates 441 to the serial input 21 of DVM 405. Thus changing the frequency potmeter setting will have no effect on the display and frequency output.

When pushbutton 803 is set to AMPL inputs 441.6/8/9, 442.1/2/12 and 445.13 are set to logic low and pins 19 and 21 of the DVM are linked via 441. The open-circuit amplitude is displayed. As the strobe function of 445 is inhibited the memory contents are frozen resulting in a fixed output frequency.

The contents of the shift registers is repeatedly shifted from the output 444.9 via 442.8/10/6/4 into the input 443.2, see above. So the memory contents is fixed.

The output data of the memory at 443, pin 12, 13, 14, 7, 6, 5, represent the two significant digits of the frequency number. If both digits are zero (display < 0100) the ERROR LED is activated via 451 and the following gate circuitry.

The **programmable frequency divider** mainly consists of the down counters 452 - 455 which are set to the memory contents at the begin of the down counting period. The task of the frequency divider is to divide the input clock rate applied to the clock input 15 of 452 by a factor N equal to the initial counter content. After N-2 pulses 458.13 becomes high so setting the J-input 10 of 434. The next counter input pulse applied to the clock input 434.13 sets the flip-flop to high. By this action the counters are inhibited via inputs 5. By the next clock pulse the flip-flop is reset and the counters are reloaded to the initial state, because load inputs 1 are set to high via gates 449.

By this operation the output pulse rate of the flip-flop 434 is fc/N , whereby fc is the input clock rate at pin 13. The output pulse width is identical to the input pulse width.

Another functional block controlled by the memory is the **digital-to-analog converter DAC** comprising FETswitches 456/457 and OP459. The 6 most significant bits of the memory contents are converted into analog voltage at output 459.6. The resulting current through 680 is routed to the summing amplifier of the control section thus presetting the main oscillator roughly to the displayed frequency.

The **variable prescaler I** comprises 426, 427, 428. The task of this prescaler is to divide the actual oscillator frequency **fact.** routed to 426.1 and 427.10 by $M = 1, 10$ or 100 for the 200 KHz , 2 MHz and 20 MHz sub-ranges respectively. For $M = 1$ **fact.** is by-passing 426 and routed via 427 to counter 428.4. As load input 11 is low no frequency division takes place and **fact.** is outputted at pin 13. For $M = 10$ the load input is high resulting in an output frequency $\text{fact.}/10$. For $M = 100$ the output frequency $\text{fact.}/10$ at 426.12 is routed via 427 to counter 428 and divided additionally by a factor of 10.

The **reference oscillator** comprises a 4 MHz oscillator circuitry with transistors 306/307 and a counter chain with 434 - 436 dividing the oscillator frequency down to 200 Hz. The output frequency of 200 Hz represents the reference frequency in the 20 Hz, 200 Hz, 2 KHz and 20 KHz sub-ranges for the PLL comprising the **phase detector + integrator + VCO** and the programmable freq. divider.

In the frequency ranges 200 KHz, 2 MHz and 20 MHz the reference oscillator output frequency is divided by 2, giving the 100 Hz reference for the **main PLL** comprising the phase detector + integrator, summing amplifier, control section, main oscillator, variable prescaler I and programmable frequency divider.

In the sub-ranges 20 Hz to 20 KHz the PLL comprising 438 and 452 generates an output frequency between 20 KHz - 400 KHz. This frequency is $200 N/\text{Hz}$, whereby N is the displayed frequency number, decimal point ignored. At the phase detector input 438.14 the 200 Hz oscillator reference is applied. At frequency input 438.3 f_{vco}/N is fed from the programmable freq. divider, f_{vco} representing the VCO output frequency at 438.4. Hence $f_{\text{vco}} = 200 N/\text{Hz}$. This frequency is routed from 438.4 through switch 439 to the variable prescaler II.

The **variable prescaler II** comprises the frequency dividers 429 - 433, 437 dividing f_{vco} by $P = 20, 200, 2000$ or $20\,000$ depending on the selected frequency sub-ranges. The output frequency $f_{\text{ref.}} = f_{\text{vco}}/P$ is routed via switch 439.2 - 4 to the main PLL phase detector. In the 20 KHz sub-range e.g. $P = 200$ is valid. Hence $f_{\text{ref.}} = f_{\text{vco}}/200$.

The **phase detector + integrator/U 1** comprises phase detector 201 and the integrator circuitry OP 202/1. In the sub-ranges 200 kHz, 2 MHz and 20 MHz $f_{\text{ref.}} = 100 \text{ Hz}$ is fed to the input of phase detector 201.1 and $f_{\text{o}}/M \cdot N$ to 201.3, with the nominal generator output frequency f_o , the division factor M of the variable prescaler I and the division factor N of the programmable frequency divider.

In the phase locked state $f_o/M \cdot N$ is 100 Hz.

In the sub-ranges 20 Hz to 20 kHz f_{vco}/P is applied to 201.1 and f_o is applied to 201.3. In the phase locked state, $f_o = f_{\text{vco}}/P$ is valid.

The outputs of the phase detector + integrator/U2 and the DAC are combined in the **summing amplifier** which controls the main oscillator frequency f_o and phase by the control section.

If the frequency setting is changed the DAC input portion of the summing amplifier effects a fast output frequency response roughly to the nominal frequency f_o . Subsequently the integrator output is fine tuning frequency and phase until phase lock is attained.

4.1.10. Power amplifier , see figs. 4.1 - 8, 47

The power amplifier mainly consists of a buffer 311/312, a d.c. low frequency path, high frequency by-pass section, complementary driver stage and complementary output stage. The amplifier with a power consumption of 9 W is supplied by the separate ± 20 V voltage regulators 471, 472.

Via buffer 141 and 142, unit 1, the selected signal is applied to the complementary emitter follower 311/312 representing the buffer stage. Behind this buffer the signal is splitted into a low frequency path routed via amplifier 461 ($V \approx 1$), resistor 693 and a high frequency path routed via capacitor 546. Both signals are added at point 'H' and fed to the driver stage 313 - 323. This driver operates as a complementary 4-stage emitter follower driving the complementary common base output stage 324 - 327. The quiescent current of the driver stage and the output stage respectively is about 125 mA. The low frequency portion of the driver output voltage is fed back to the driver input point 'H' via resistors 739/741, OP 461 and resistor 693. The voltage gain of the power amplifier ($V \approx 6.9$) is mainly performed in the output stage and is approximately two times the ratio of the output load (50Ω) to the effective emitter resistor of each output transistor 326, 327. The DC OFFSET is controlled by potmeter 604 via resistor 686 to the input of 461 and can be set up to ± 5 V.

The front panel ATTENUATION pushbuttons 802 permit selection of 3 dB, 6 dB, 10 dB and 20 dB by switching resistors 751 - 767. For 600Ω output impedance the amplifier output is connected via resistor 698 to the OUTPUT socket.

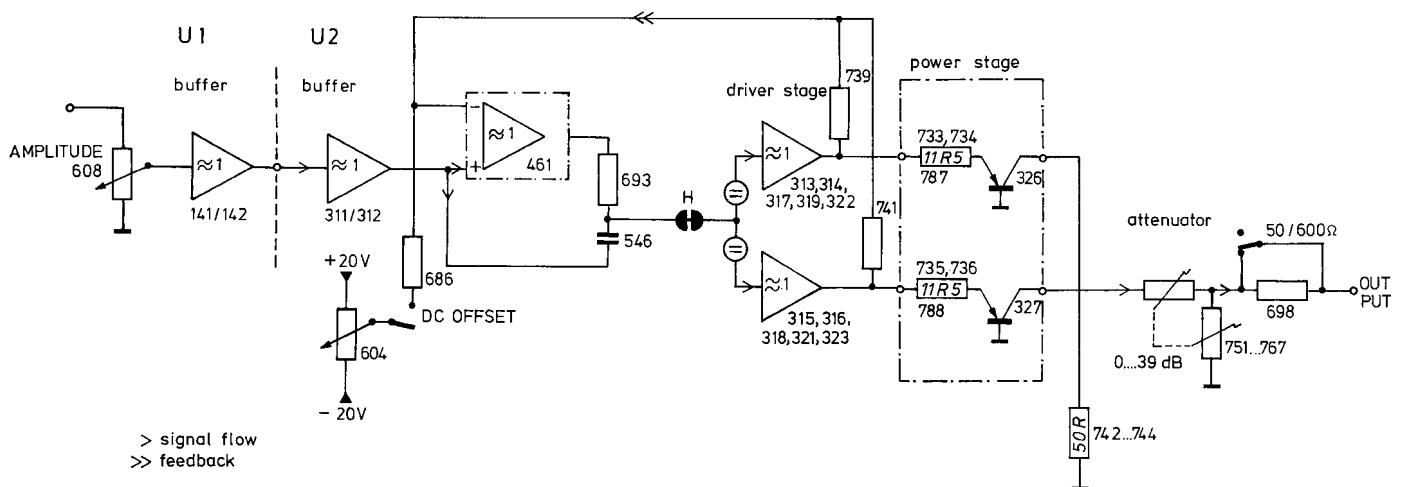


Fig. 4.1 - 8 Power amplifier

4.1.11. Power supply, fan

All five power supplies are realized by means of voltage regulators: a fixed one for +5 V and two adjustable regulators for ± 20 V are installed on unit 1. For good electrical and thermal conditions of the power amplifier 2 separate adjustable regulators 471/472 for ± 20 V are installed on unit 2. Solder joints A – K on unit 1 and 2 serve for convenient fault finding.

For good heat abduction and stable signal conditions the generator is equipped with a fan, supplied by a secondary voltage (24 Vac) of the mains transformer.

4.2. ACCESS TO PARTS

Before dismantling the instrument, the safety regulations in accordance with para. 2.2 must be strictly observed.

4.2.1. Cabinet, see 2.5.

4.2.2. Knobs

- Remove the cap from the knob.
- Unscrew the nut and remove the knob.
- When replacing the knob, ensure that the white mark is correctly aligned with the text plate markings.

4.2.3. Text plate

- Remove the cabinet, see 2.5.
- Remove the turn-knobs, see 4.2.2.
- Remove the plastic cover of the mains switch.
- The text plate can now be removed.
Be careful:
The textplate is fitted to the frontplate by double sided adhesive tape.

4.2.4. Pushbutton unit

Replacing a pushbutton lever.

The single pushbutton lever can be replaced from the front.

- Push the spring towards the pushbuttons.
- Remove the wire strap and/or lift the plastic reed between the contacts.
- Carefully tear the pushbutton lever out of the pushbutton.

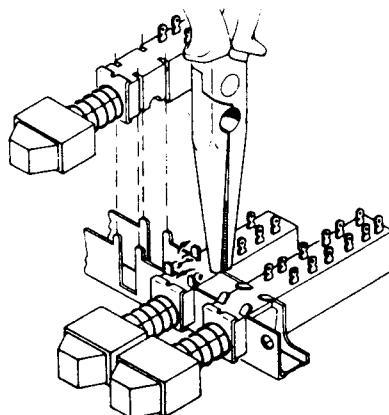
Replacing a switch of the pushbutton unit (see figure below)

- Straighten the 4 retaining lugs of the relevant switches as shown in the figure below.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed circuit board (e.g. with a suction soldering iron).
- Bend the 4 retaining lugs back to their original positions.
- Solder the new switch on to the printed circuit board.

Note: The pushbutton array for the attenuator 802/1-4 must completely be desoldered before you can demount a single pushbutton.

4.2.5. Replacing a rotary switch

For the repair of defective rotary switches on Unit 1 complete switches must be replaced. Single switch-wafers are not available.



4.3. CHECK AND ADJUSTMENT

4.3.1. General

- The limits mentioned in this paragraph are valid only for a newly adjusted instrument and therefore might deviate from the values as stated in paragraph 1.2. "Technical Data".
- Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of $(+23 \pm 3)^\circ\text{C}$ and when connected to a mains voltage of $220\text{ V} \pm 5\%$. For adequate temperature stability during adjustment, the cabinet should be removed only for a short time and so far that the required adjusting element is just accessible.
- If not explicitly stated otherwise, the voltage potentials refer to the relevant contact measured against circuit earth (\perp).
- The following abbreviations are used for setting and measuring instruments:

X	\triangleq Button pressed
—	\triangleq Button not pressed/unlocked
o	\triangleq Button only tipped
rh	\triangleq extreme right-hand position
lh	\triangleq extreme left-hand position
m	\triangleq mid-position
ml	\triangleq position in the middle between m and lh
+	\triangleq LED, lighting
*	\triangleq LED, flashing
o—	\triangleq outputs, unloaded
●—	\triangleq OUTPUT, terminated with 50Ω , e.g. PM 9585; pushbutton $50\Omega/600\Omega$ unlocked
○—	\triangleq double (coarse/fine) control
↓	\triangleq keep setting concerned
 Vac, Vdc	\triangleq Digital multimeter for a.c. and d.c. measurements, e.g. 8920A (Fluke)
OSC	\triangleq Oscilloscope e.g. PM 3055
C/T	\triangleq Counter /Timer e.g. PM 6665
Fg	\triangleq Function generator e.g. PM 5132
DA	\triangleq Distortion analyzer e.g. HP 334A
SA	\triangleq Spectrum analyzer
50Ω	\triangleq 50Ω terminating resistor e.g. PM 9585

4.3.2. Preparations

- All trimming potentiometers and capacitors in mid-position; (only for complete new adjustment).
- Solder joints A to K must be closed. To be opened for failure detection only.
- Terminate the OUTPUT by a 50Ω resistor, if not stated otherwise.

4.3.3. General functional test

- Set the instrument to POWER ON
- Adjust power supply according to seq. 1.1 to 1.5 of the following table
- Actuate all controls for rough functional test of the generator and check all input and output sockets.

4.3.4. Table of checks and adjustments

Seq.	MODE	FREQ HZ	FREQUENCY	PERIOD	MOD/SWEEP	s	s	PERIOD	sweep control		frequency control		WAVE FORM	DUTY CYCLE	AMPLI- TUDUE	OUT- PUT	outputs	INT	Inputs	internal measurement	LED indicators	measuring point: generator display/ instrument value (see 4.3.1.)	measured value	adjustment, control pos.	remarks						
									START	STOP	HOLD	RESET	STD BY	TRIG	LOCK	TUNE	DC	AM/FM	START	DC	DEPTH	PHASE	OFFSET	603	608	807	808				
1.																															
1.	84	85	601 /-1 /-2	602 /-1 /-2	86	606	81/1 81/2 81/3	81/4 82/1	HOLD	RESET	STD BY	TRIG	LOCK	TUNE	DUTY	ATTEN-	50 Ω	TT	PEN LIFT	AM	SWEET/FM	TRIG & BURST	U2	354	355	356	361	362			
1.1.	NORMAL	2 k	m m						-	-	-	-	-	OFF	m	m	~	m	-	-	Vpp	ERROR									
1.2.	NORMAL	2 k	m m																												
1.3.																															
1.4.																															
1.5.																															
1.6.																															
1.7.																															
2.1.																															
2.2.																															
2.3.																															
2.4.																															
2.5.																															
2.6.																															
2.7.																															
2.8.																															
2.9.																															
2.10.																															
3.1.																															
3.2.																															
3.3.																															
3.4.																															
3.5.																															
3.6.																															
3.7.																															
3.8.																															
3.9.																															
3.10.																															
3.11.																															
3.12.																															
3.13.																															
3.14.																															
3.15.																															
3.16.																															
3.17.																															
3.18.																															
3.19.																															
3.20.																															
3.21.																															
3.22.																															
3.23.																															

* from LO 04 .. onward 20 MHz range

repeat adjustment using added trimmer
C487/U1 at 15.8 MHz - 16.2 MHz

SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

General directives

- Take care that creepage distance and clearances have not been reduced
 - Before soldering, wires:
 - should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridgity shall be maintained by cable clamps or cable lacing.
 - Replace all insulating guards and -plates.

4.4.2.

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 4.5.1.

Checking the protective earth connection

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5Ω . During measurement the mains cable should be moved. Resistance variations indicate a defect.

Checking the insulation resistance

Measure the insulation resistance at $U = 500$ Vdc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than $2\text{ M}\Omega$.

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 4.5.1.

Note:
2 M Ω is a minimum requirement at 40 °C and 95 % relative humidity. Under normal conditions the insulation resistance should be much higher (10 to 20 M Ω).

4.5. SPARE PARTS

4.5.1. General

Standard Parts

Electrical and mechanical parts replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE:

Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts

In addition to the standard electronic components, some special components are used:

- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument, marked with 'S' in the parts list.

ATTENTION:

Both type of components may only be replaced by components obtained through your local Philips organisation.

4.5.2. Static sensitive components

This instrument contains electrical components that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

4.5.3. Handling MOS devices

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental over-voltages. In storing and handling them, the following precautions are recommended.

CAUTION:

Testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should normally be connected to ground via a resistor.

4.5.4. Mechanical parts, miscellaneous, parts not on units

Item	Figure	Quantity	Order number	Description	
1		1	5322 447 40049	cover, brown	
2		4	5322 462 10222	foot (bottom side), brown	
3		2	5322 520 34164	bearing bush	
4		2	5322 530 84075	spring	
5		2	5322 528 34101	ratchet	
6		2	5322 532 51481	ring for handle, brown	
7		2	5322 498 54048	arm for handle	
8		1	5322 498 54051	carrying handle	
9		2	5322 414 30043	knob, brown	
10		4	5322 462 44176	foot (rear side)	
11		1	5322 502 14164	coin-slot screw (rear side)	
12		1	4822 530 70124	locking washer (rear side)	
13		7	5322 532 51309	insulating bush for BNC socket	
15	34	1	5322 321 14048	mains cable 1850	*S
16	34	1	5322 401 14275	cable clamp	*S
17	34	1	5322 325 54067	lead through	*S
18	34	1	5322 325 60119	pull relief	*S
19		4	5322 462 34125	print holder	
100		1	4822 253 30016	fuse 400 mAT	*S
—		1	4822 253 30019	fuse 800 mAT	*S
20	31	8	5322 414 70016	cap for knob 601–608, brown	
21	31	4	5322 414 70015	cap for knob 84–87, brown	
22		12	5322 414 20033	knob for pushbutton, brown	
23		6	5322 414 30053	knob pos. 603–608, brown	
24		2	5322 414 30041	knob 601/602, 10 mm Ø, brown	
25		4	5322 414 30071	knob pos. 84–87, brown	
26		2	5322 414 30037	knob 601/602, 14 mm Ø, brown	
27		5	5322 267 10004	BNC connector	
802, 805	32 a	2	5322 267 10173	BNC connector (long)	
28		—	5322 390 24013	silicon paste DC 340	
80		1	5322 146 20672	mains transformer	*S
29	37	1	5322 361 10238	fan	*S
809	37	1	5322 121 44364	line filter FKE 250	*S
30		1	5322 450 60217	window	
31	39, 44	5	5322 255 40263	heat sink, unit 1/2	
32	44	4	5322 255 40264	heat sink, unit 2	
33	40	1	5322 530 80231	S-clip, unit 4	
34		11	5322 526 10015	damping bead 3.5 x 3 mm	
35		7	5322 526 10212	damping bead 3.5 x 7.5 mm	

*S = Safety component, see chapter 4.5.1.

Item	Fig.	Quantity	Order number	Description
36		1	5322 255 44047	IC-socket, 28-pole
37		4	5322 255 44122	IC-socket, 14-pole
83	31	1	5322 276 14433	mains switch
81/1/2	31	2	5322 276 10959	pushbutton switch U1
81/4	31	1	5322 276 10959	pushbutton switch U1
81/3	31	1	5322 276 10961	pushbutton switch U1
82/2	31	1	5322 276 10961	pushbutton switch U1
82/1/3	31	2	5322 276 14221	pushbutton switch U1
802	31	1	5322 276 40292	pushbutton switch U2
803	31	1	5322 276 10962	pushbutton switch U2
84	31	1	5322 273 80247	rotary switch
85	31	1	5322 273 80248	rotary switch
86	31	1	5322 273 50201	rotary switch
87	31	1	5322 273 60127	rotary switch
601/602	31	2	5322 101 20669	carbon potm. 4k7+4k7
603	31	1	5322 103 64043	potmeter 5k0/5
604	31	1	5322 101 64029	carbon potm. 22 kOhm lin.
605	31	1	4822 101 20441	carbon potm. 10 kOhm lin.
606	31	1	4822 101 20416	carbon potm. 4k7 lin.
607	31	1	5322 101 40101	carbon potm. 10 kOhm lin.
608	31	1	5322 102 10183	carbon potm. 1k0+1k0 Ohm
372	37	1	4822 122 30103	capacitor 22 N/63 V cer.plate
450	37	1	5322 122 30108	capacitor 100 N/50 V
487 - 492	37	6	5322 122 30108	capacitor 100 N/50 V
486	37	1	4822 121 40176	capacitor 1 μ F/100 V
527/528	37	2	5322 116 50511	resistor 48.7 Ohm MR 25
559	37	1	5322 116 55571	resistor 14.0kOhm MR 25
561	37	1	5322 116 50926	resistor 40.2 Ohm MR 25
640	37	1	4822 116 51268	resistor 100 kOhm MR 25
691	37	1	5322 116 54459	resistor 75 Ohm MR 25

S = Safety component, see chapter 4.5.1.

4.5.5. Electrical partsUNIT 1TRANSISTORS/U1

101-103	4822	130	44197	BC558B
104-106	4822	130	40937	BC548B
107	4822	130	44104	BC328
128	4822	130	44568	BC557B
129	4822	130	40959	BC547B
131	4822	130	40937	BC548B
132	4822	130	40902	BF240
133,134	4822	130	40937	BC548B
135,136	5322	130	40417	BSX20
137,141	5322	130	44127	2N2894A
138	5322	130	44201	2N4035
139,142	5322	130	40417	BSX20
144,145	4822	130	44568	BC557B
146	5322	130	44509	BFQ16
147-149	4822	130	40959	BC547B
151,152	4822	130	40937	BC548B
153,154	4822	130	44197	BC558B
155-157	4822	130	40937	BC548B
158,159	4822	130	44568	BC557B
161,178	4822	130	40959	BC547B
162,171	4822	130	44197	BC558B
163-165	4822	130	40937	BC548B
166	4822	130	41095	BC337-16
172,173	4822	130	40937	BC548B
174,176	4822	130	44197	BC558B
175	4822	130	40937	BC548B
177	4822	130	44568	BC557B
179,182	4822	130	44197	BC558B
181,183	4822	130	40937	BC548B
184	4822	209	80365	CA3046 (TBA331) trans.array
185-187	4822	130	40902	BF240
188-192	4822	130	40959	BC547B
193,195	4822	130	44237	BF450
194,196	4822	130	40902	BF240
197	4822	130	40959	BC547B
198	5322	130	44201	2N4035

INTEGRATED CIRCUITS/U1

201	5322	209	85821	MC4044L
202,211	5322	209	85512	MC1458N
203	4822	209	80617	UA741CN
204,205	5322	209	86056	LM308AN
206,208	5322	209	71647	MC1456 P 1
207,214	5322	209	86056	LM308AN
209,219	5322	209	71647	MC1456 P1
213	5322	209	86355	LF355N
215	5322	209	84167	SN74SOON
216	5322	209	84823	N74LSOON
218	5322	209	85571	NE531N

221	5322	209	84778	OQ011
222	5322	209	14104	HEF4066BP
223	5322	209	85201	SN74LS132N
225	5322	209	85512	MC1458N
226	5322	209	84841	UA7805UC
227	5322	209	85565	78GCU1
228	5322	209	86349	79GCU1

DIODES/U1

251,252	4822	130	34233	BZX79-B5V1
254	4822	130	34297	BZX79-B10
255	4822	130	34048	BZX75-C2V8
271,272	4822	130	34233	BZX79-B5V1
273,274	4822	130	34297	BZX79-B10
275,277	4822	130	34049	BZX75-C2V1
276	5322	130	34321	1N4151
278	4822	130	30229	AAZ15
279	4822	130	31248	BZY46-C2VO
281	5322	130	34413	BZX61-C16
282,283	5322	130	34321	1N4151
284	5322	130	34413	BZX61-C16
285,286	4822	130	34197	BZX79-B12
291	4822	130	34233	BZX79-B5V1
292	4822	130	30229	AAZ15
293-295	4822	130	34233	BZX79-B5V1
296,299	5322	130	34321	1N4151
297	4822	130	34173	BZX79-B5V6
298	4822	130	34281	BZX79-B15
301	4822	130	34233	BZX79-B5V1
302,303	4822	130	34488	BZX79-B11
304-325	5322	130	34321	1N4151
326,328	4822	130	34297	BZX79-B10
327	5322	130	34321	1N4151
331,332	4822	130	34047	BZX75-C1V4
335-337	5322	130	32031	SKB2/08/L5A, RECTIFIER

CAPACITORS/U1

ITEM	ORDERING	NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
350	4822	124 40434	22UF		35V	ELECTROLYTIC
351	4822	124 20678	47UF		10V	ELECTROLYTIC
352	5322	121 40227	1.5UF	10	100V	POLYESTER FOIL
353	5322	121 40324	15NF	10	400V	" "
354	4822	121 40231	100NF	10	100V	" "
355,356	5322	124 10016	68UF		20V	TANTAL
357	4822	121 40257	330NF	10	100V	POLYESTER FOIL
358	5322	121 40283	3.3UF	10	100V	" "
359,361	4822	122 30043	10NF	-20+80	100V	CERAMIC PLATE
360	4822	124 40178	100UF		16V	ELECTROLYTIC
362,363	4822	122 30034	470PF	2	100V	CERAMIC PLATE
364	4822	122 30103	22NF	-20+80	63V	" "
365	4822	122 30128	4.7NF	10	100V	" "
366,368	4822	122 31221	1.5NF	10	100V	" "
369,371	4822	122 30043	10NF	-20+80	100V	" "
370,373	4822	122 31221	1.5NF	10	100V	" "

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
377,391	4822 124 20698	22UF		25V	ELECTROLYTIC
392	4822 125 50131	1.8-18PF		250V	TRIMMER
394	5322 121 50829	4.7UF	5	100V	POLYESTER FOIL
396	5322 121 41533	47ONF	5	100V	" "
397	5322 121 50832	49.9NF	1	63V	" "
398	4822 122 31521 ^{may be omitted}	56PF	2	100V	CERAMIC PLATE
399	5322 121 50831	4.87NF	1	63V	POLYESTER FOIL
401	5322 125 50183	11-12OPF		150V	TRIMMER
402	4822 122 31348	39OPF	5	100V	CERAMIC PLATE
403	4822 125 50017	5.5-65PF		100V	TRIMMER
404	5322 121 40224	4.7UF	10	100V	POLYESTER FOIL
405	5322 121 40175	47ONF	10	100V	" "
406	5322 121 54108	47NF	1	63V	" "
407	4822 121 50539	4.7NF	1	63V	" "
408	4822 122 30034	47OPF	2	100V	CERAMIC PLATE
409,411	4822 122 30043	10NF	-10+80	100V	" "
412,419	4822 124 20698	22UF		25V	ELECTROLYTIC
413	4822 122 31045	4.7PF	0.25PF	100V	CERAMIC PLATE
415,418	4822 122 30103	22NF	-20+80	63V	" "
416	4822 124 20678	47UF		10V	ELECTROLYTIC
417	4822 122 31072	47PF	2	100V	CERAMIC PLATE
420	4822 122 31067	33PF	2	100V	" "
421,425	4822 122 30103	22NF	-20+80	63V	" "
422,423	4822 122 30034	47OPF	2	100V	" "
424	4822 124 20698	22UF		25V	ELECTROLYTIC
426,427	4822 122 30043	10NF	-20+80	100V	CERAMIC PLATE
428	4822 122 30027	1NF	10	100V	" "
431	4822 121 50566	1NF	1	250V	POLYESTER FOIL
432	4822 121 50088	3.6NF	1	63V	" "
433	5322 121 54108	47NF	1	63V	" "
434	5322 121 40175	47ONF	10	100V	" "
435	5322 121 40224	4.7UF	10	100V	" "
436	4822 122 30034	47OPF	2	100V	CERAMIC PLATE
437-439	4822 122 30027	1NF	10	100V	" "
441-443	4822 122 31413	15OPF	2	100V	" "
444,451	4822 122 30103	22NF	-20+80	63V	" "
446	4822 122 30097	15PF	2	100V	" "
452,453	5322 121 40308	22NF	10	400V	POLYESTER FOIL
454	4822 122 31045	4.7PF	0.25PF	100V	CERAMIC PLATE
455-458	4822 122 30043	10NF	-10+80	100V	" "
461	4822 122 30128	4.7NF	10	100V	" "
462,463	4822 124 20698	22UF		25V	ELECTROLYTIC
471	4822 124 20722	1UF		63V	"
472	5322 121 40323	100NF	10	100V	POLYESTER FOIL
473	4822 124 20722	1UF		63V	ELECTROLYTIC
474-476	4822 121 40232	22ONF	10	100V	POLYESTER FOIL
477	4822 124 20779	2200UF		16V	ELECTROLYTIC
478,479	4822 124 20798	3300UF		40V	"
481-483	4822 121 40232	22ONF	10	100V	POLYESTER FOIL
485	4822 121 40252	6.8UF	10	100V	" "

COILS/U1

491,492	5322	158	10538	COIL 220MUH
493	5322	158	10343	COIL,CHOKE 1.5MUH
494-496	5322	158	10132	COIL,FXC-BROAD.BAND

RESISTORS/U1

ITEM	ORDERING	NUMBER	OHM	TOL (%)	TYPE	REMARKS
502	4822	100 10036	4K7		LIN	POTM.TRIMMING
503	5322	116 55535	1M	1	MR25	METAL FILM
529	5322	116 55034	10K5	0.1	MR25	" "
531,532	5322	116 54155	100K	0.1	MR25	" "
533	5322	116 55034	10K5	0.1	MR25	" "
536	5322	116 51418	887E	0.1	MR25	" "
537,544	5322	101 14051	220E		LIN	POTM.TRIMMING
538	5322	116 50747	1K	0.1	MR25	METAL FILM
543	5322	116 51418	887E	0.1	MR25	" "
545,557	5322	116 50746	100E	0.1	MR25	" "
546,554	4822	100 10079	47K		LIN	POTM.TRIMMING
549	5322	101 14047	470E		LIN	" "
555	5322	116 50747	1K	0.1	MR25	METAL FILM
556	4822	100 10079	47K		LIN	POTM.TRIMMING
558	5322	101 14008	2K2		LIN	" "
562,681	5322	101 14011	100E		LIN	" "
564	5322	116 54888	20K	0.1%	MR25	METAL FILM
571,572	5322	116 50748	10K	0.1%	MR25	METAL FILM
625	5322	101 14069	22K		LIN	POTM.TRIMMING
629-632	4822	100 10036	4K7		LIN	" "
634	5322	111 90137	10K			RESISTOR-NETW.
647	4822	100 10075	100E		LIN	POTM.TRIMMING
657	4822	100 10019	220E		LIN	" "
674	5322	101 14011	100E		LIN	" "
675,679	4822	116 51105	470E	5	PR37	METAL FILM
704,751	5322	116 55458	442K	1	MR25	" "
706,738	4822	100 10037	1K		LIN	POTM.TRIMMING
709,769	4822	100 10029	2K2		LIN	" "
714	5322	116 54188	1M	1	MR30	METAL FILM
721	4822	100 10035	10K		LIN	POTM.TRIMMING
752	4822	100 10079	47K		LIN	" "
754,772	4822	100 10037	1K		LIN	" "
826,829	4822	100 10038	470E		LIN	" "
836	5322	101 14051	220E		LIN	" "
840,894	4822	100 10019	220E		LIN	" "
844	4822	100 10035	10K		LIN	" "
863,866	4822	100 10037	1K		LIN	" "
887	4822	100 10079	47K		LIN	" "
891	4822	100 10038	470E		LIN	" "
896	5322	116 54188	1M	1	MR30	METAL FILM

TRANSISTORS/U2

301	5322	130	44452	BFQ11, FET
302-305	4822	130	40988	BC328-25
306,307	4822	130	44196	BC548C
308	4822	130	44197	BC558B
311,313	4822	130	44568	BC557B
312,316	4822	130	40959	BC547B
314	4822	130	44237	BF450
315	4822	130	40902	BF240
317,324	4822	130	44197	BC558B
318,325	4822	130	40937	BC548B
319,323	5322	130	40468	2N2905A
321	5322	130	44034	2N2219A
322	5322	130	44015	BFW16A
326	4822	130	40824	BD140
327	4822	130	40823	BD137

DIODES/U2

351,352	4822	130	34297	BZX79-B10
353	5322	130	34397	BZX93 } 1N823 } see item 612, page 4 - 30
353	5322	130	34405	
363	4822	130	34174	BZX79-B4V7
364-372	4822	130	34233	BZX79-B5V1

INTEGRATED CIRCUITS/U2

401	5322	209	86355	LF355N
402	5322	209	71647	MC1456 P1
403	4822	209	80617	UA741CN
404	5322	209	85512	MC1458N
405	5322	209	85327	HEF4739VP
406	5322	209	84994	SN74LS05N
407	5322	209	84035	N7416N
408	5322	209	86282	N7447AN
415	5322	209	14054	HEF4081BP
416,421	5322	209	14067	HEF4075BP
417	4822	209	10185	HEF4069UBP
418	5322	209	14045	HEF4001BP
419,425	5322	209	14053	HEF4071BP
420	5322	209	85703	N74LS01A
422	5322	209	14074	HEF4072BP
423	5322	209	14068	HEF4050BP
424	5322	209	84994	SN74LS05N
426	5322	209	85255	N74LS9ON
427	5322	209	84823	N74LSOON
428	5322	209	85329	N74LS192N
429-433	5322	209	14184	HEF40192BP
434,437	5322	209	14055	HEF4027BP
435,436	5322	209	14064	HEF4518BP
438	5322	209	14126	HEF4046BP
441,442	5322	209	14046	HEF4011BP
443,444	5322	209	14485	HEF4094BP
445	5322	209	14191	HEF4528BP
449	5322	209	14046	HEF4011BP
451	5322	209	14052	HEF4025BP
452-455	5322	209	14075	HEF4510BP
456,457	5322	209	14104	HEF4066BP

458	5322	209	14234	HEF4078BP
459	4822	209	80617	UA741CN
461	5322	209	85571	NE531N
471	5322	209	85565	78GCU1
472	5322	209	86349	79GCU1

CAPACITORS/U2

ITEM	ORDERING	NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
501,502	4822	122 31056	12PF	2	100V	CERAMIC PLATE
503	4822	122 30103	22NF	-20+80	63V	" "
504	4822	121 50566	1F	1	250V	POLYESTER FOIL
505	4822	122 30095	27OPF	10	100V	CERAMIC PLATE
506,516	4822	121 40232	22ONF	10	100V	POLYESTER FOIL
510	4822	124 20679	100UF		10V	ELECTROLYTIC
511	5322	125 54083	2.5-27PF		100V	TRIMMER
512	5322	122 31682	18PF	2	100V	CERAMIC PLATE
513	4822	122 31173	22OPF	10	100V	" "
514	5322	122 34201	12OPF	2	100V	" "
515	4822	122 30027	1NF	10	100V	" "
517	4822	122 30103	22NF	-20+80	63V	" "
518	4822	124 20678	47UF		10V	ELECTROLYTIC
519	4822	122 31243	82PF	2	100V	CERAMIC PLATE
520	4822	124 20679	100UF		10V	ELECTROLYTIC
521	5322	121 40233	68ONF	10	100V	POLYESTER FOIL
522	5322	121 44232	22NF	10	400V	" "
523	4822	122 30128	4.7NF	10	100V	CERAMIC PLATE
524-527	4822	122 30043	1ONF	-20+80	100V	" "
530	4822	124 20945	33UF		10V	ELECTROLYTIC
540	4822	122 30114	2.2NF	10	100V	CERAMIC PLATE
541,542	4822	122 30043	1ONF	-20+80	100V	" "
543	4822	122 31212	0.47PF	0.25PF	500V	" "
544,545	4822	122 30103	22NF	-20+80	63V	" "
546	5322	121 44232	22NF	10	400V	POLYESTER FOIL
547,548	4822	122 30103	22NF	-20+80	63V	CERAMIC PLATE
549,551	4822	122 30128	4.7NF	10	100V	" "
550	4822	122 30114	2.2NF	10	100V	" "
552-557	4822	122 30103	22NF	-20+80	63V	" "
558,559	4822	121 40232	22ONF	10	100V	POLYESTER FOIL
561,562	4822	122 30027	1NF	10	100V	CERAMIC PLATE
563,564	4822	122 30103	22NF	-20+80	63V	" "
565,566	4822	122 31504	10OPF	2	100V	" "
567,568	4822	124 20698	22UF		25V	ELECTROLYTIC
569	4822	121 40257	33ONF	10	100V	POLYESTER FOIL
570,580	4822	124 20944	1UF		25V	ELECTROLYTIC
571	4822	124 40244	2.2UF		63V	"

RESISTORS/U2

ITEM	ORDERING	NUMBER	OHM	TOL (%)	TYPE	REMARKS
601	5322	116 54285	19K6	0.1	MR25	METAL FILM
603	5322	101 14008	2K2		LIN	POTM .TRIMMING
604-608	5322	116 54285	19K6	0.1	MR25	METAL FILM
609,614	5322	116 54892	200K	0.1	MR30	" "
612	5322	116 55033	1K05	0.1	MR25	" " for BZX93
612	5322	116 55278	909E	1	MR25	" " for 1N823

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
613	5322 116 54292	1K69	0.1	MR25	" "
615,617	5322 116 55036	12K1	0.1	MR25	" "
616	4822 100 10037	1K		LIN	POTM.TRIMMING
622	5322 116 54227	100K	0.1	MR30	METAL FILM
624	4822 110 72192	1.5M	5	VR25	HIGH VOLT.RESIST.
625	5322 116 55258	511K	1	MR25	METAL FILM
661	4822 110 72196	2M2	5	VR25	HIGH VOLT.RESIST.
673	5322 116 55283	402K	0.5	MR25	METAL FILM
684	5322 101 14069	22K		LIN	POTM.TRIMMING
685	5322 116 55371	383K	0.5	MR25	METAL FILM
698,702	4822 100 10038	470E		LIN	POTM.TRIMMING
718,719	5322 116 55509	130E	5	PR37	POWER METAL FILM
733-736	5322 116 51457	31E6	1	MR52	METAL FILM
742-744	5322 116 53959	150E	1	MR52	" "
782	4822 100 10038	470E		LIN	POTM.TRIMMING
785	4822 100 10019	220E		LIN	" "

COILS/U2

657	5322 158 10243	COIL,100MUH
770	5322 158 10271	COIL,FXC-BROADBAND
780	5322 158 10276	COIL,4.7MUH
790	5322 158 10278	COIL,1.0MH

CRYSTAL/U2

801	4822 242 70325	CRYSTAL 4.0000 MHZ
-----	----------------	--------------------

DIODES/U3

354-362	4822 130 80692	PLED - P314N
366	5322 130 34321	1N4151

DISPLAY/U3

409-413	5322 130 34389	HP5082-7730,DISPLAY
---------	----------------	---------------------

TRANSISTORS/U4

108	4822 130 44197	BC558B
109,111	5322 130 44127	2N2894A
112	5322 130 40417	BSX20
113	5322 130 40542	BFX89
114	4822 130 40937	BC548B
115	4822 130 41024	BF245B
116,117	4822 130 40902	BF240
118	5322 130 44034	2N2219A
118	5322 130 44015	BFW16A onwards series LO 13/...
119-123	5322 130 44127	2N2894A
124,125	5322 130 40542	Q BFX89
126	4822 130 40902	BF240
127	4822 130 44237	BF450

DIODES/U4

256,268	5322 130 32239	BA481
257-259	4822 130 34233	BZX79-B5V1
260	4822 130 30861	BZX79-B7V5
261	4822 130 34233	BZX79-B5V1
262	4822 130 34195	BZX79-C13
263	5322 130 34397	BZX90
264	5322 130 34321	1N4151
265-267	4822 130 34048	BZX75-C2V8
269	4822 130 34047	BZX75-C1V4

CAPACITORS/U4

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
372,374	4822 122 30128	4.7N	10	100	CERAMIC PLATE
373,384	4822 122 31061	18PF	2	100	" "
375*	4822 122 31221	1.5N	10	100	" "
376-383	4822 122 30099	3.3N	10	100	" "
385	5322 125 50184	1.2-5.5PF		100	TRIMMER
386	4822 122 30094	22OPF	10	100	CERAMIC PLATE
387	4822 122 31056	12PF	2	100	" "
388,389	4822 122 30099	3.3N	10	100	" "

RESISTORS/U4

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
593*	5322 116 51461	2.61E	1	MR25	METAL FILM
599	5322 101 14051	22OE		LIN	POTM . TRIMMING
617	5322 101 10294	1.OK		LIN	" "

* omitted from series LO 013... onwards

LACQUERED METAL FILM RESISTORS MR25

style	resistance range		tol.	series	temperature coefficient	limiting voltage(r.m.s.)	service code number:	
	4.99 Ω – 1M Ω						* = 4822 116	# = 5322 116
MR25	4.99 Ω	– 1M Ω	± 1%	E96	50ppm/°C*	250V	(last 5 digits see table)	
			* for resistance values lower than 49.9 Ω; 100ppm/°C.					
4.99	# 50568	17.4	# 54432	56.2	# 53644	178	# 53572	576 # 54527
5.11	* 52999	17.8	# 50418	57.6	# 54447	182	# 54493	590 * 53584
5.23	* 53019	18.2	# 54083	59	# 54448	187	# 80144	
5.36	* 53001	18.7	# 50895			191	# 54495	604 # 54528
5.49	* 53002	19.1	-----	60.4	# 53657	196	# 55273	619 * 51232
5.62	* 53003	19.6	# 53721	61.9	# 53645			634 # 54531
5.76	# 54413			63.4	# 54375	200	# 53731	649 # 53646
5.90	* 53004	20	* 53797	64.9	# 53647	205	# 55365	665 # 54533
6.04	* 53005	20.5	# 53635	66.5	# 54454	210	# 54036	681 * 51233
6.19	# 80148	21	# 54433	68.1	# 53264	215	# 55274	698 # 54037
6.34	* 53006	21.5	# 53426	69.8	# 53621	221	* 51223	
6.49	* 53007	22.1	# 50983			226	# 53242	715 # 53622
6.65	* 53008	22.6	# 53637	71.5	# 53528	232	# 54498	732 # 54535
6.81	* 53009	23.2	# 54434	73.2	# 54458	237	# 53259	750 * 51234
6.98	* 53011	23.7	# 53606	75	# 53339	243	# 53607	768 # 55427
7.15	* 53012	24.3	# 54435	76.8	# 50494	249	# 53573	787 # 53648
7.32	* 53013	24.9	# 53608	78.7	# 53561	255	# 80296	
7.50	* 53014	25.5	# 54436			261	# 53549	806 # 80128
7.68	* 53015	26.1	# 53723	80.6	# 54461	267	# 80479	825 # 53541
7.87	* 53016	26.7	# 54067	82.5	* 52814	274	# 53427	845 # 54542
8.06	* 53017	27.4	# 50493	84.5	# 54463	280	# 55586	866 # 53474
8.25	* 53018	28	# 55588	86.6	# 54464	287	# 53221	887 # 55574
8.45	# 54421	28.7	# 60478	88.7	# 54465	294	# 54507	
8.66	# 51051	29.4	# 54084					909 # 55278
8.87	# 54101			90.9	# 53626	301	# 55366	931 # 54546
9.09	# 53516	30.1	# 53638	93.1	# 54467	309	# 55464	953 # 80229
9.31	# 54422	30.9	# 54437	95.3	# 53563	316	# 53514	976 # 80307
9.53	# 54258	31.6	# 54964	97.6	# 54468	324	# 53556	
9.76	# 54423	32.4	# 55421			332	* 51226	1K * 51235
		33.2	# 53612	100	# 55549	340	# 54514	1K02 * 52893
10	* 52891	34	-----	102	* 52895	348	# 53591	1K05 * 52898
10.2	* 52896	34.8	# 53725	105	* 52897	357	# 50603	1K07 * 52903
10.5	* 52901	35.7	# 54439	107	* 52902	365	# 53575	1K1 * 51236
10.7	* 52905	36.5	# 80116	110	* 52906	374	# 54517	1K13 * 52912
11	* 52909	37.4	# 54158	113	* 52911	383	# 55368	1K15 * 52121
11.3	* 52915	38.3	# 50954	115	* 52916	392	* 51228	1K18 * 52951
11.5	* 52948	39.2	# 53544	118	* 52949			1K21 * 52956
11.8	* 52954			121	* 52955	402	# 53639	1K24 * 52962
12.1	* 52959	40.2	# 53493	124	* 52961	412	# 54521	1K27 # 53321
12.4	* 53029	41.2	# 54108	127	# 54479	422	# 53592	1K3 * 51238
12.7	* 53031	42.2	# 53515	130	# 53548	432	* 51229	1K33 # 55422
13	* 53032	43.2	# 50519	133	# 53424	442	# 53641	1K37 # 55446
13.3	* 53033	44.2	# 50818	137	# 54483	453	# 80121	1K4 # 55569
13.7	* 53034	45.3	# 50795	140	# 55568	464	# 53232	1K43 # 55572
14	* 53035	46.4	# 53248	143	# 54485	475	# 53249	1K47 # 53185
14.3	* 53036	47.5	# 80483	147	# 53569	487	# 55451	1K5 * 51239
14.7	* 53037	48.7	# 53643	150	* 52846	499	# 53545	1K54 # 53571
15	* 51221	49.9	# 54441	154	# 53653			1K58 # 80106
15.4	# 55573			158	# 55418	511	* 51282	1K62 # 55359
15.8	* 53038	51.1	# 53213	162	# 53523	523	# 80122	1K65 # 54566
16.2	* 53039	52.3	# 54443	165	# 54488	536	# 53335	1K69 # 53491
16.5	# 54109	53.6	# 54444	169	# 54489	549	# 53618	1K74 # 50629
16.9	# 53654	54.9	# 54445	174	# 55461	562	* 51231	1K78 # 53208

service code number:		* = 4822 116		# = 5322 116			
1K82	# 54568	5K9	# 53251	19K1	# 54639	61K9	* 51265
1K87	# 52123			19K6	# 53258	63K4	# 54681
1K91	# 54569	6K04	# 54601			64K9	# 50514
1K96	# 53237	6K19	# 55426	20K	# 53732	66K5	# 80228
		6K34	# 53619	20K5	# 55419	68K1	* 51266
2K	# 53605	6K49	# 53579	21K	# 54644	69K8	# 54684
		6K65	# 80124	21K5	# 50451		
2K05	# 53634	6K81	* 51252	22K1	* 51257	71K5	# 53623
2K1	* 51244	6K98	# 54605	22K6	# 55291	73K2	# 50666
2K15	# 50767			23K2	# 54645	75K	* 51267
2K21	* 51245	7K15	# 80125	23K7	# 53537	76K8	# 80126
2K26	# 53243	7K32	# 55372	24K3	# 80478	78K7	# 53649
2K32	# 80108	7K5	# 55324	24K9	# 80265		
2K37	# 53536	7K68	# 55373	25K5	# 54649	80K6	# 54688
2K43	# 80109	7K87	# 53529	26K1	# 53261	82K5	# 55374
2K49	# 53574			26K7	* 53532	84K5	# 54691
2K55	# 54577	8K06	# 55428	27K4	* 53078	86K6	# 80357
2K61	# 53327	8K25	# 51498	28K	# 80297	88K7	# 55452
2K67	# 54578	8K45	# 80334	28K7	# 55462		
2K74	* 53055	8K66	# 53625	29K4	# 53655	90K9	# 53582
2K8	# 55587	8K87	# 54614			93K1	* 80424
2K87	# 55279			30K1	# 53209	95K3	# 80291
2K94	# 51396	9K09	* 51284	30K9	# 80298	97K6	# 55591
		9K31	# 54616	31K6	# 53262		
3K01	* 51246	9K53	# 53562	32K4	# 54658		
3K09	* 53186	9K76	# 54618	33K2	* 51259	100K	* 51268
3K16	* 53021			34K	# 54659	102K	* 52895
3K24	# 53611	10K	* 51253	34K8	# 53429	105K	# 55356
3K32	* 51247	10K2	* 52894	35K7	# 80299	107K	* 52904
3K4	# 54584	10K5	* 52899	36K5	# 53557	110K	* 52844
3K48	# 55367	10K7	# 55357	37K4	# 51397	113K	* 52914
3K57	# 54586	11K	* 52907	38K3	# 55369	115K	* 52947
3K65	# 53245	11K3	* 52913	39K2	* 51262	118K	* 52953
3K74	# 54588	11K5	# 55358			121K	* 52958
3K83	* 53079	11K8	* 52952	40K2	# 53613	124K	# 54705
3K92	* 51249	12K1	* 52957	41K2	# 55423	127K	# 54706
		12K4	# 54626	42K2	# 53431	130K	* 53118
4K02	# 55448	12K7	# 53488	43K2	* 51263	133K	* 53344
4K12	# 54593	13K	* 53082	44K2	# 55449	137K	# 54628
4K22	# 53246	13K3	# 55276	45K3	# 54669	140K	# 54259
4K32	# 53559	13K7	# 54628	46K4	# 53314	143K	# 54711
4K42	# 53578	14K	# 55571	47K5	# 80482	147K	# 53256
4K53	# 80489	14K3	# 54631	48K7	# 53615	150K	* 51269
4K64	# 53212	14K7	* 53531	49K9	# 50674	154K	# 53604
4K75	# 53614	15K	* 51255			158K	# 54715
4K87	# 55445	15K4	# 55459	51K1	* 53121	162K	# 53535
4K99	# 53616	15K8	# 80292	52K3	# 54673	165K	# 54717
		16K2	# 55361	53K6	* 53202	169K	# 53345
5K11	# 53494	16K5	# 80293	54K9	# 54675	174K	# 54719
5K23	# 80303	16K9	# 53322	56K2	* 51264	178K	# 53555
5K36	# 53546	17K4	# 55447	57K6	# 54677	182K	# 54722
5K49	# 54598	17K8	# 53235	59K	* 80036	187K	* 53796
5K62	* 51281	18K2	# 80475			191K	# 55363
5K76	# 80304	18K7	# 55362	60K4	# 80305	196K	# 55364

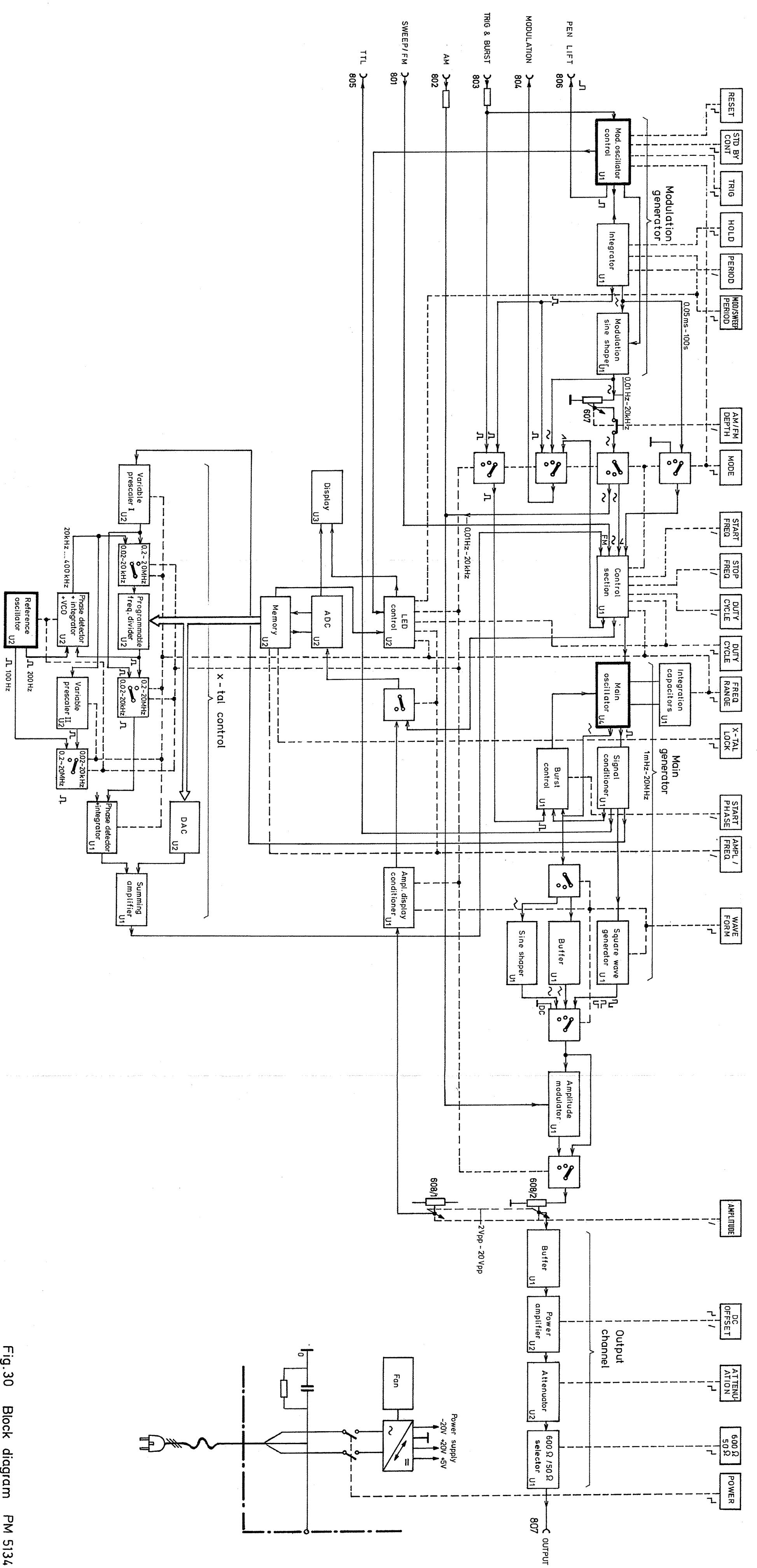


Fig.30 Block diagram PM 5134

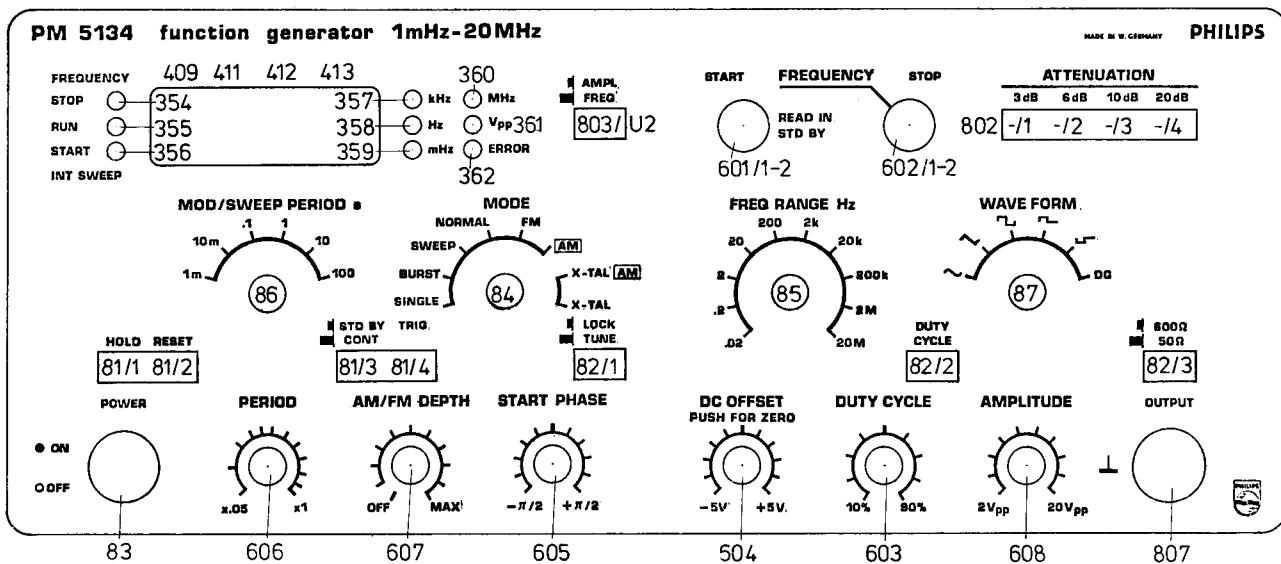


Fig. 31 Front view

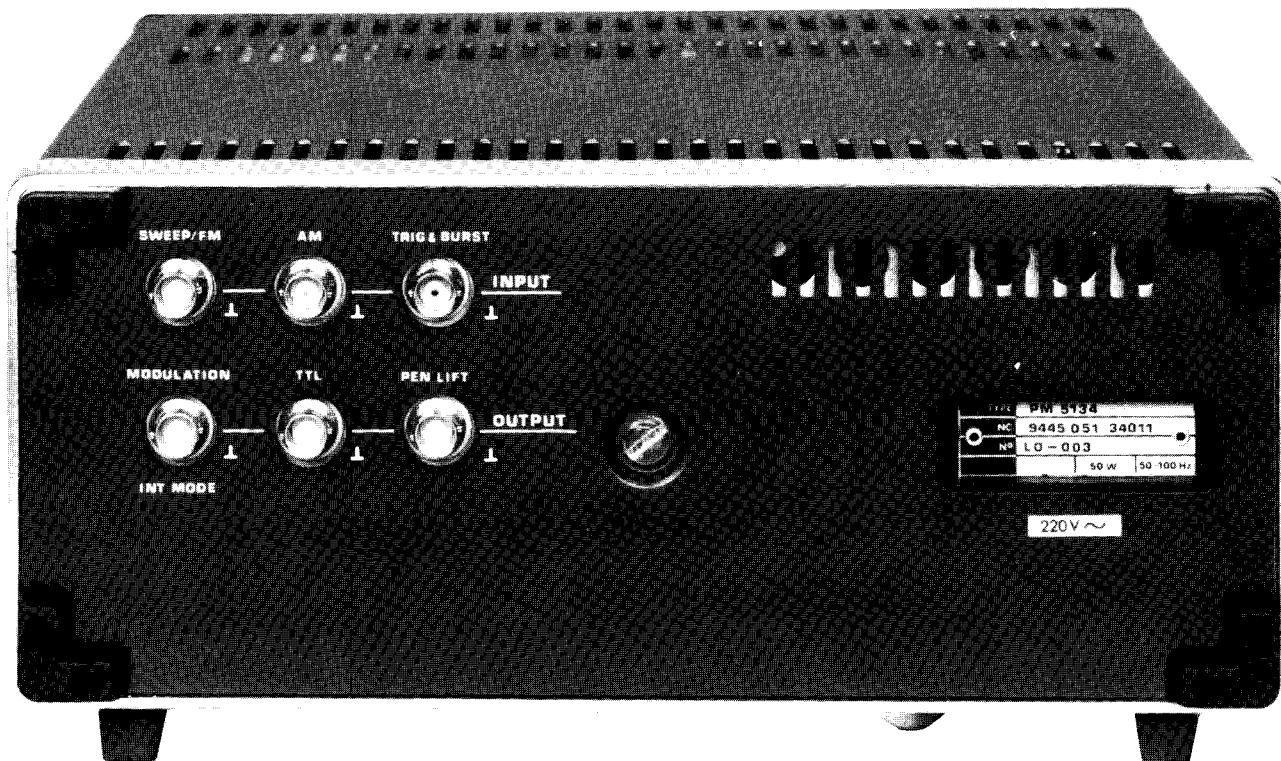


Fig. 32 Rear view

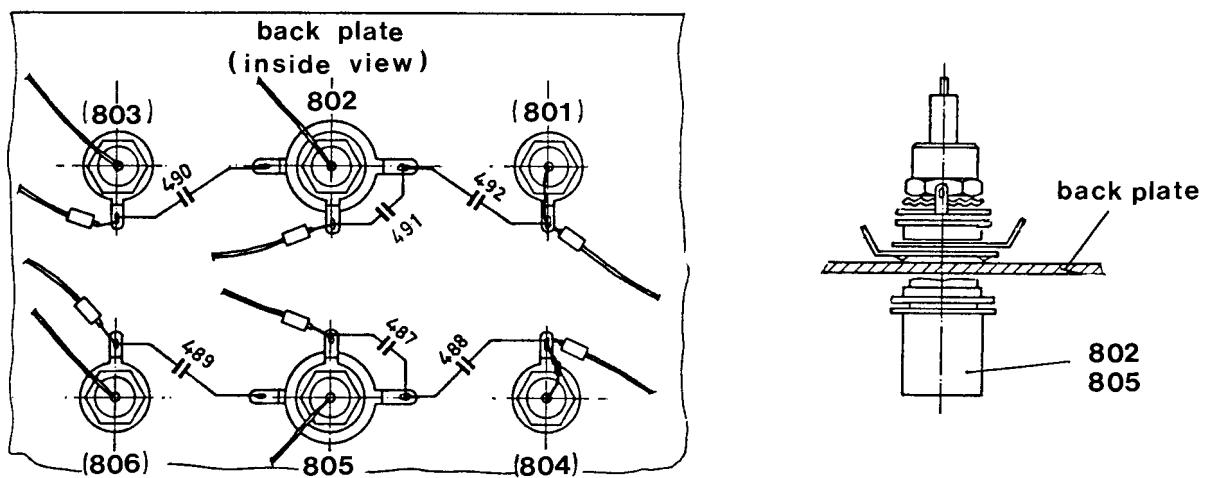


Fig. 32a Back plate (internal view)

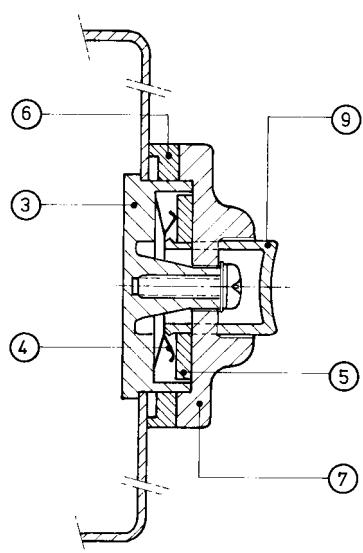


Fig. 33 Handle: spare parts

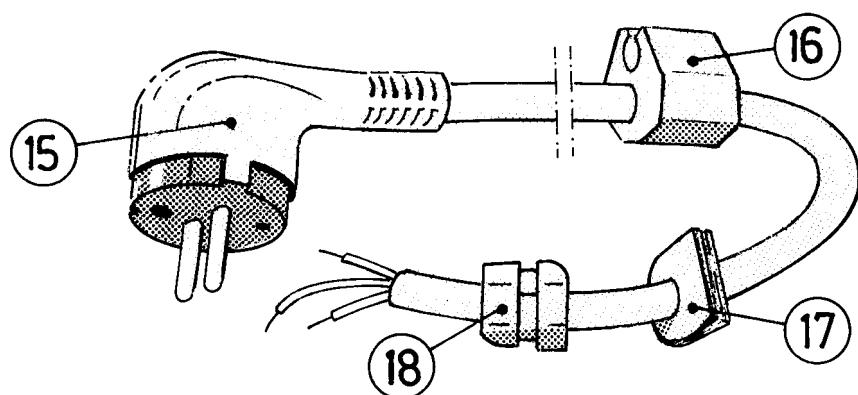
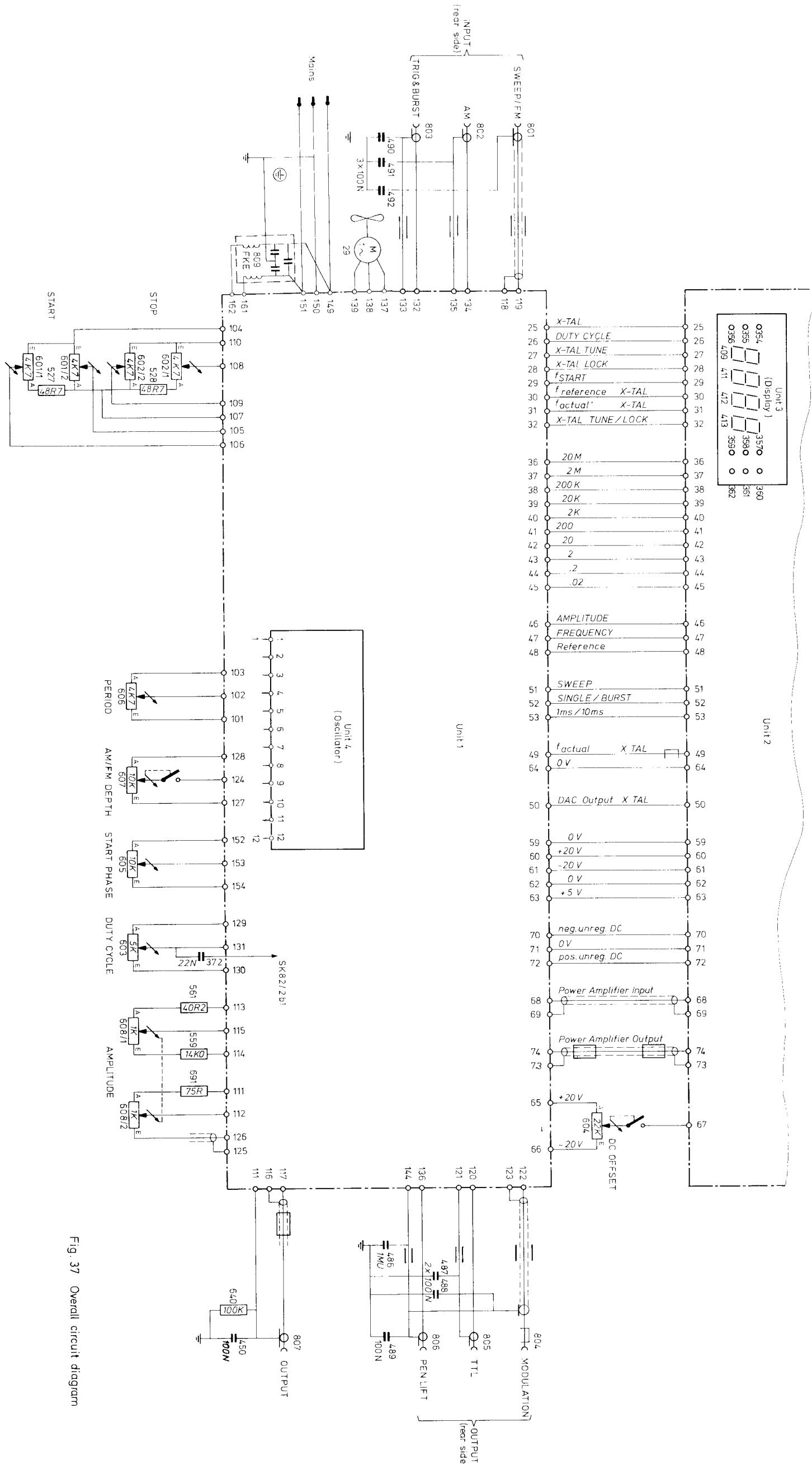


Fig. 34 Mains cable: spare parts



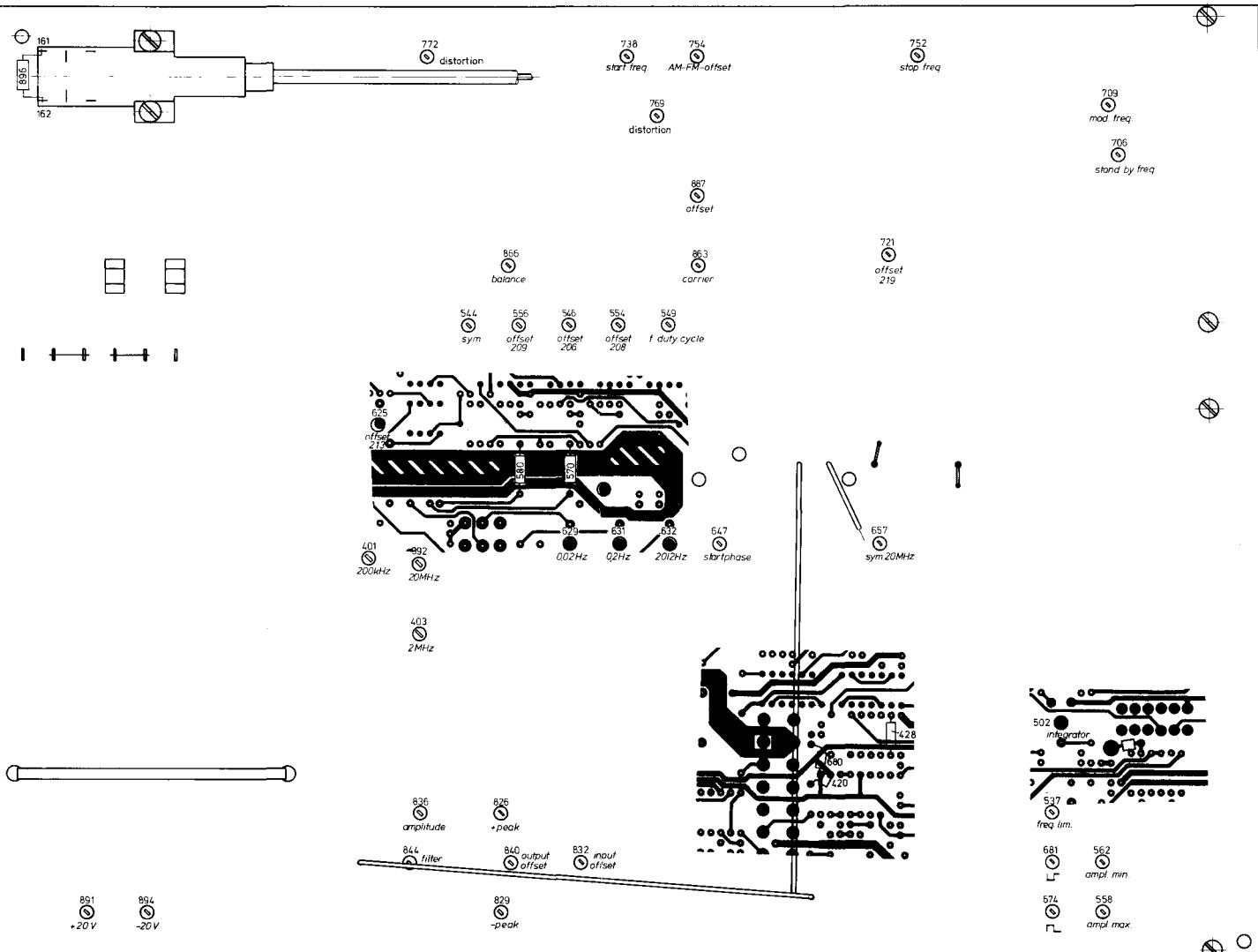
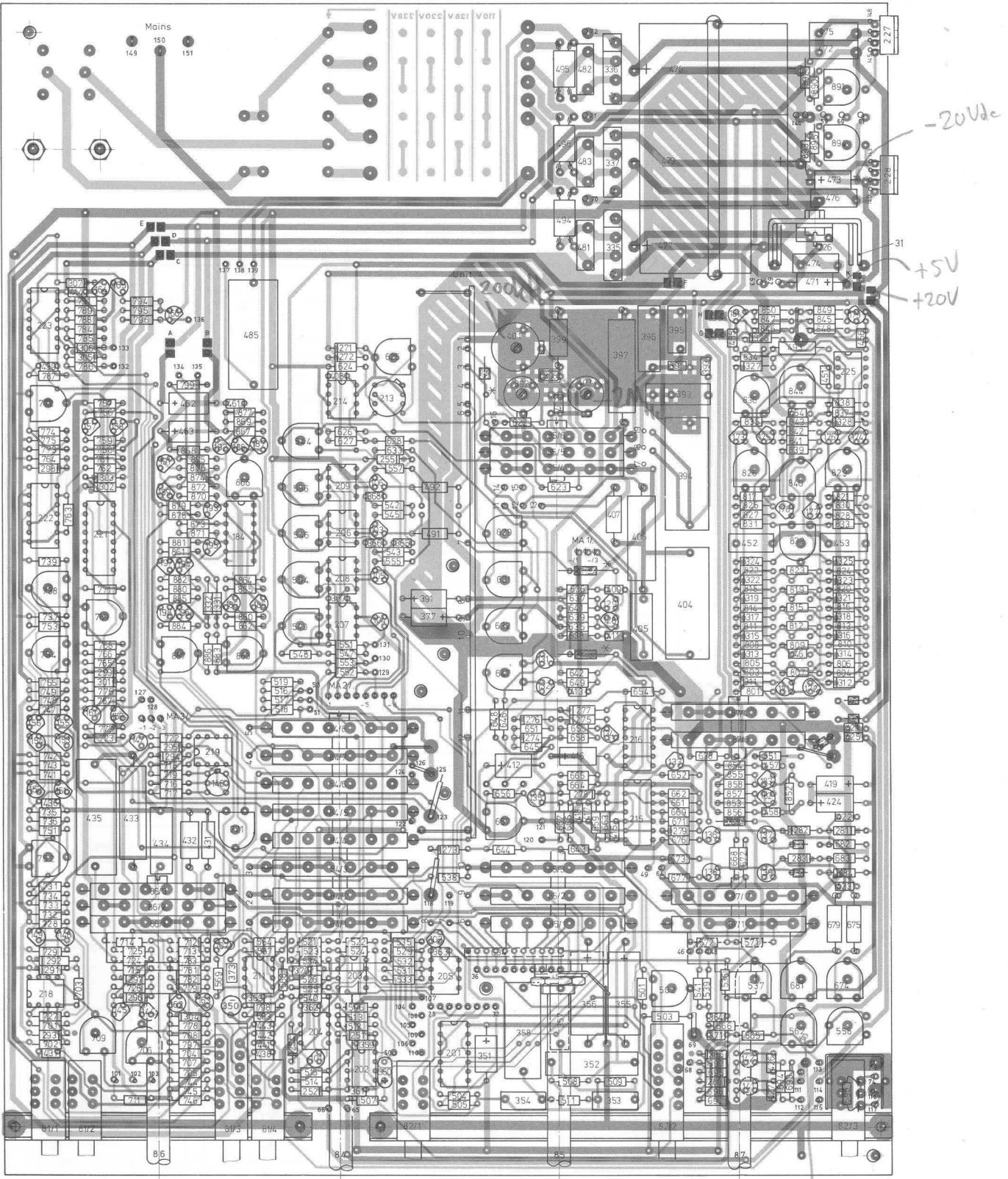


Fig. 38 Unit 1, adjusting elements



* foil is fixed between tabulator core and p.c.b.

Fig. 39 , Unit 1, component lay-out

562
2V 99

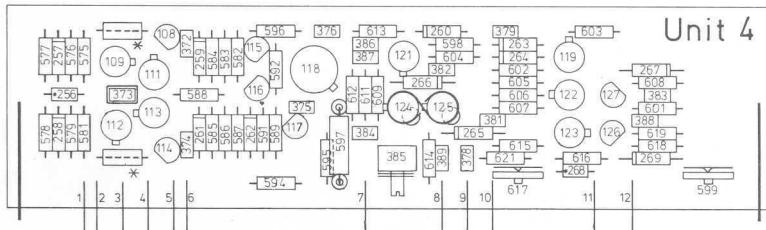


Fig. 40 Unit 4 , component lay- out

Unit 1

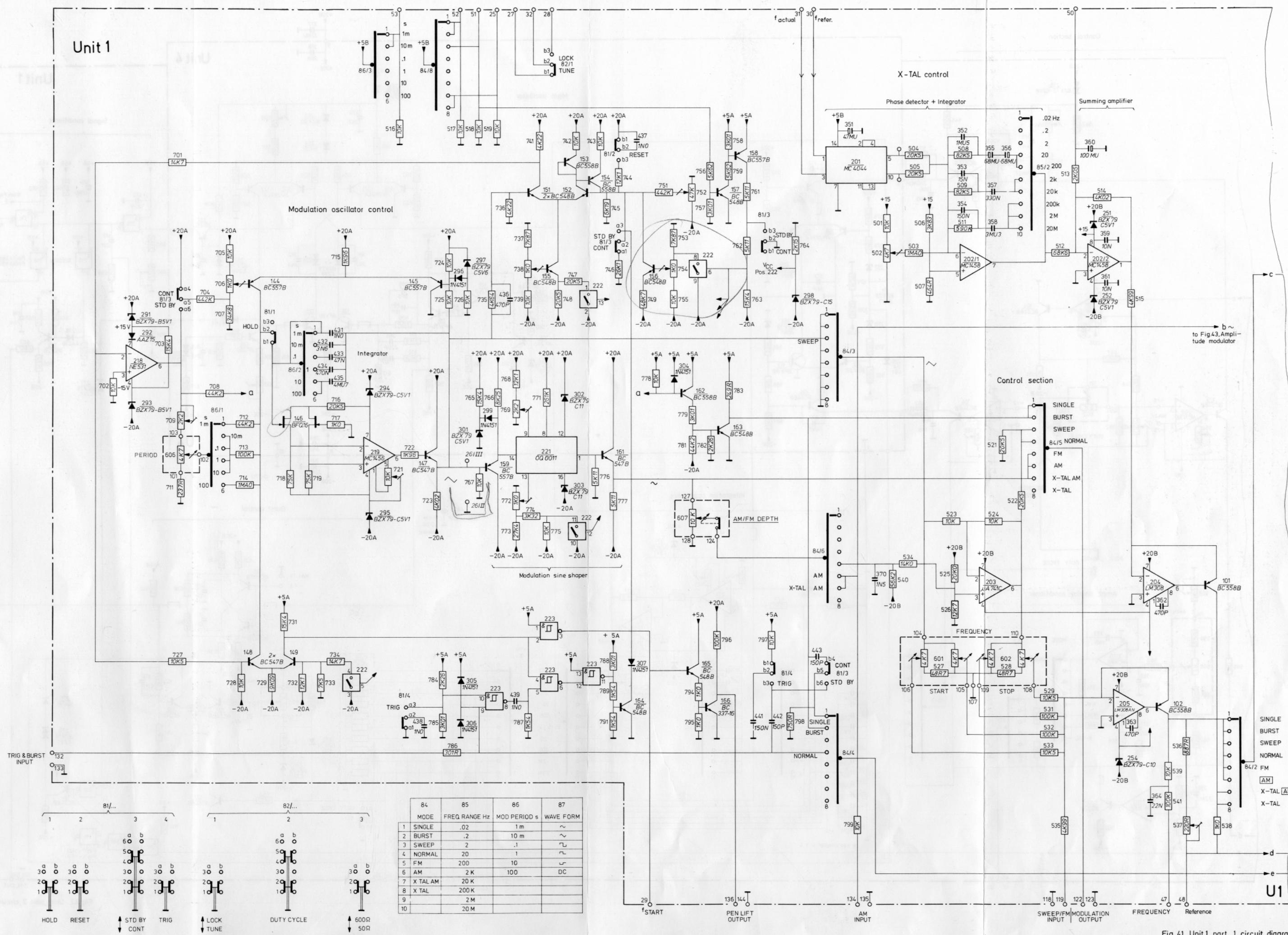


Fig.41 Unit 1,part 1,circuit diagram

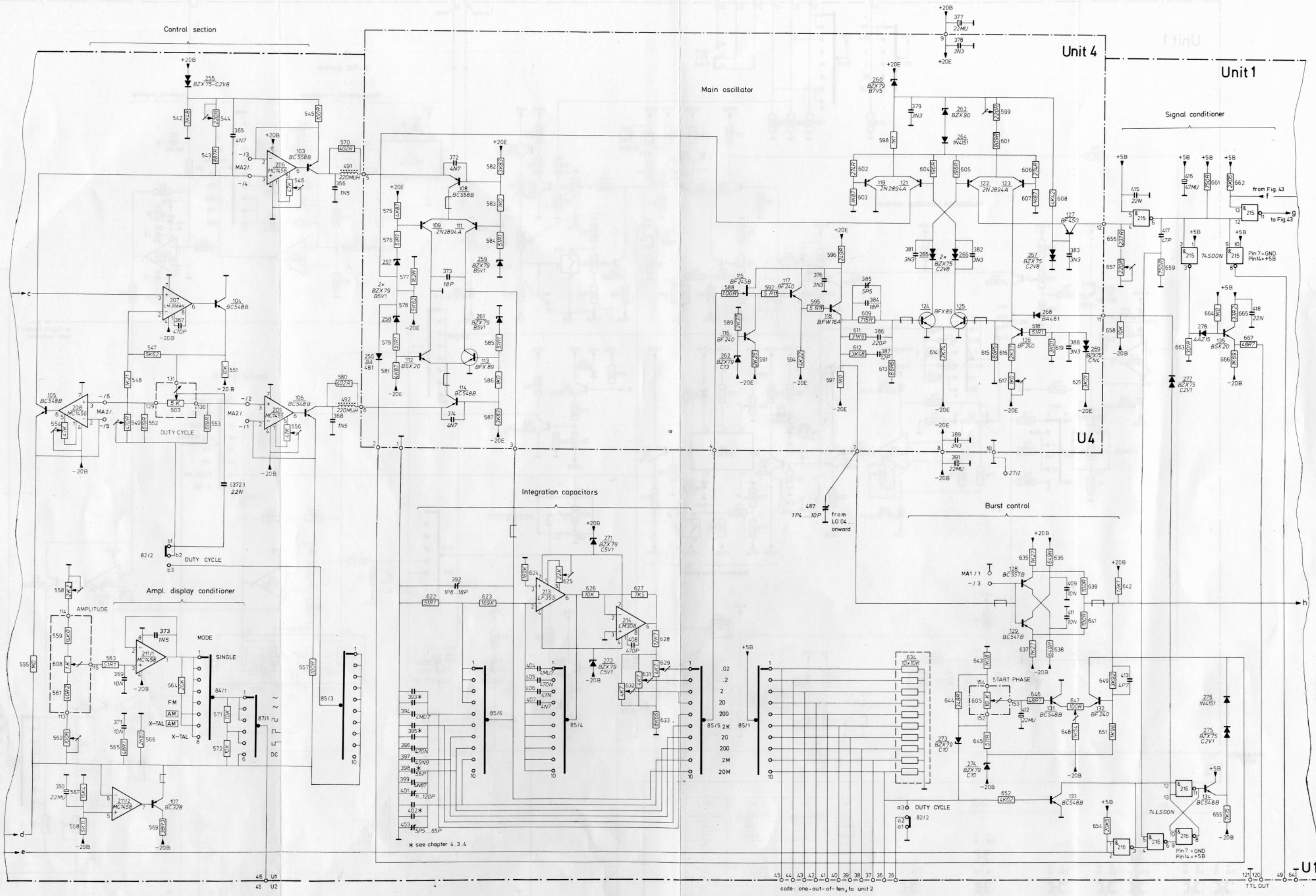


Fig. 42 Unit1, part 2, circuit diagram

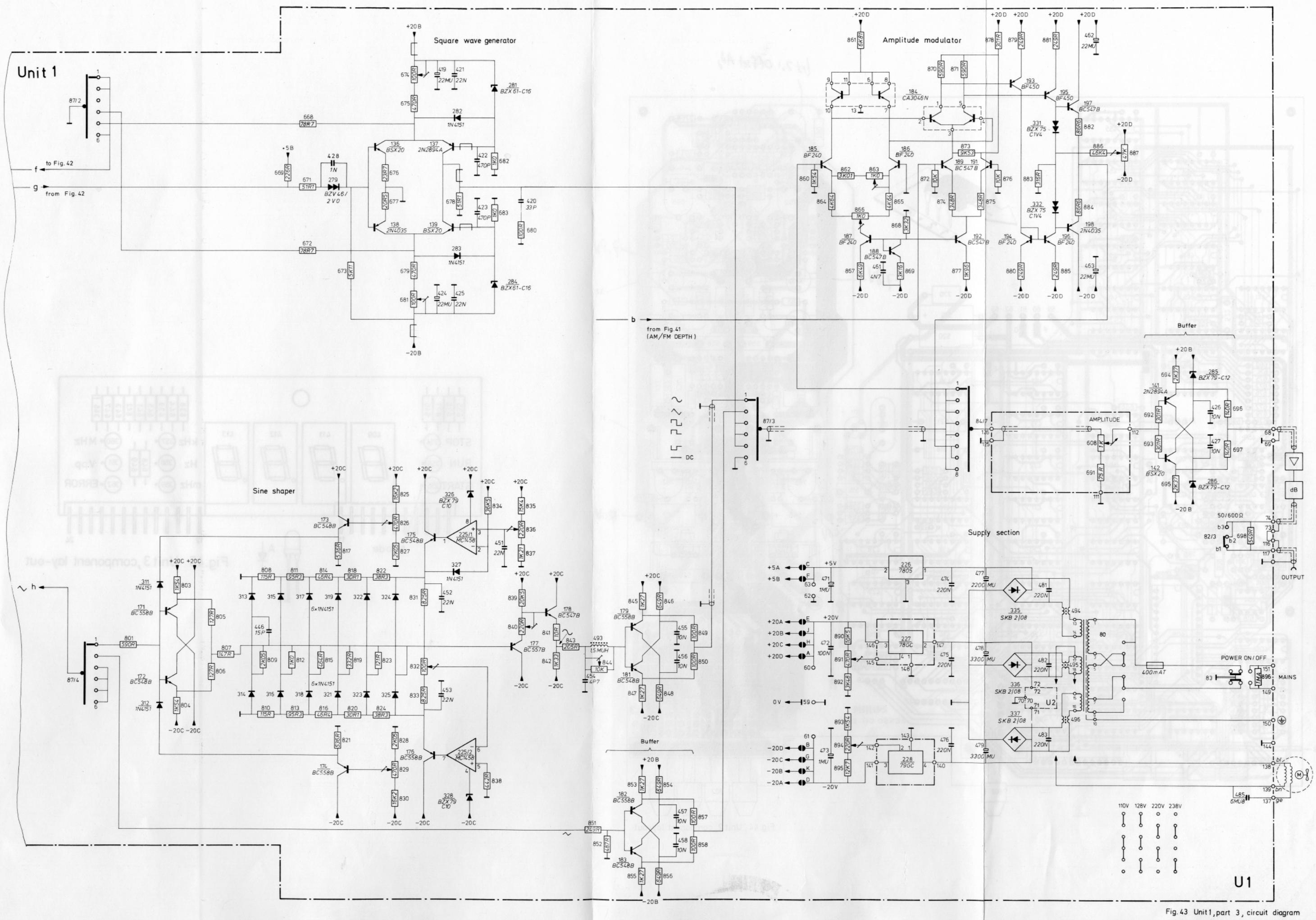


Fig. 43 Unit1,part 3 , circuit diagram

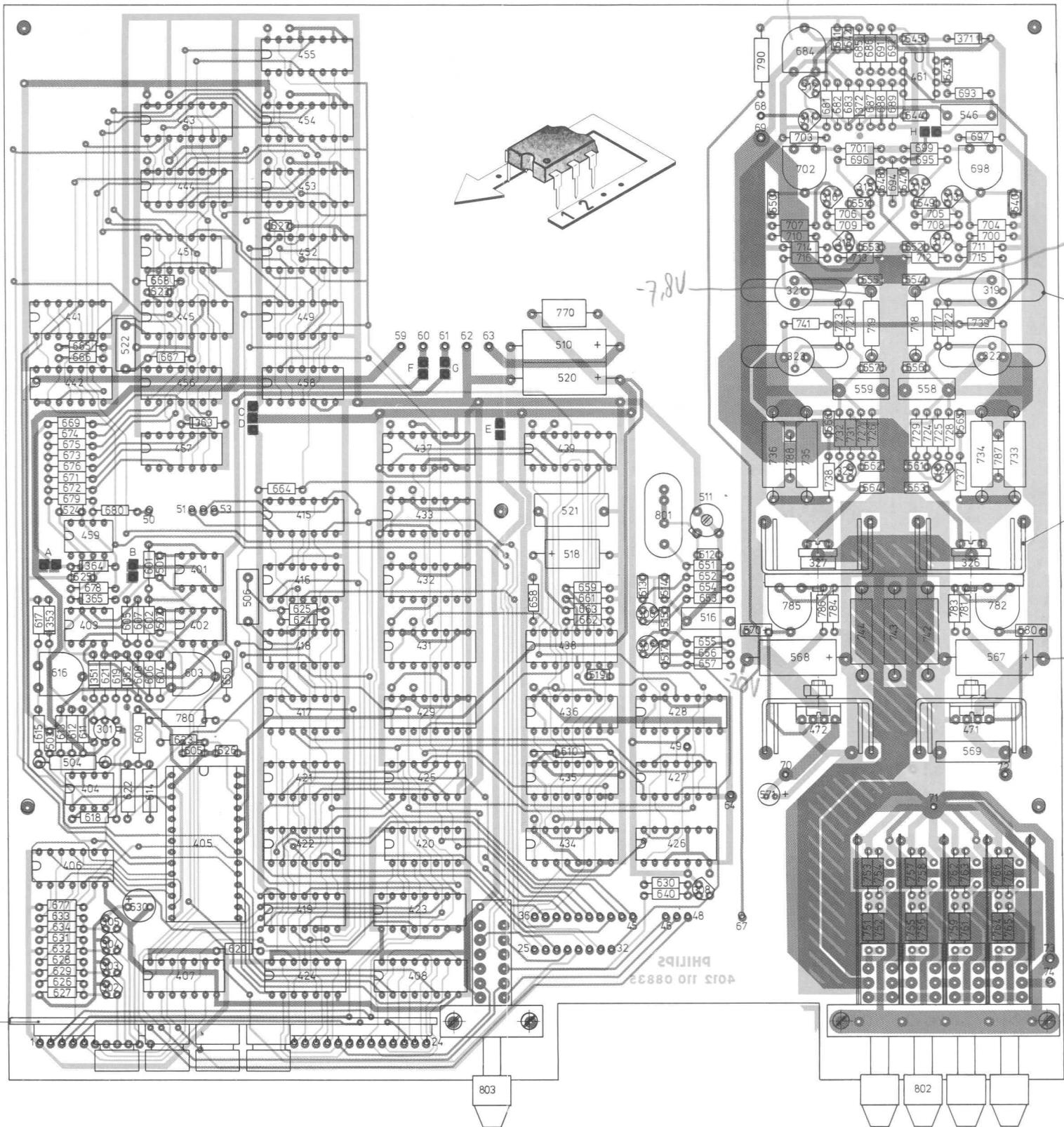


Fig.44 Unit 2, component lay-out

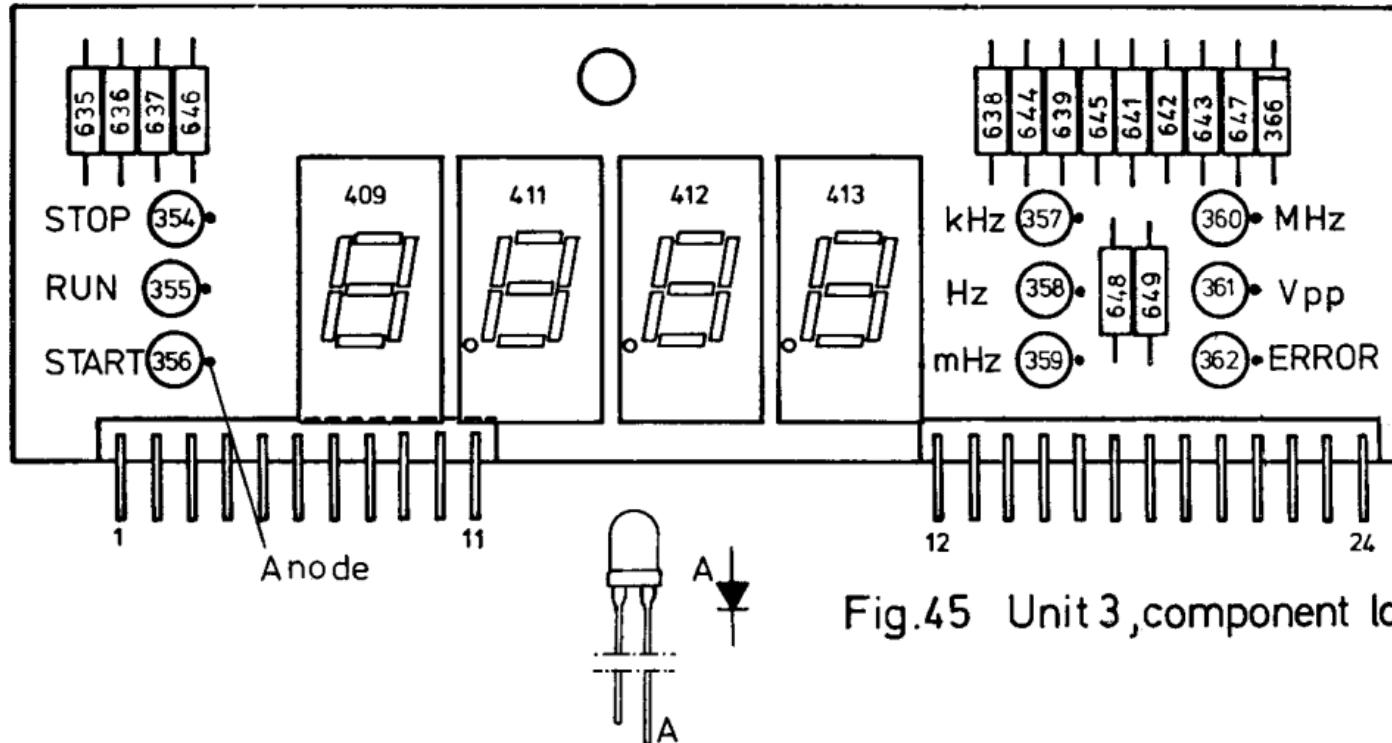


Fig.45 Unit 3 ,component lay-out

TPUT

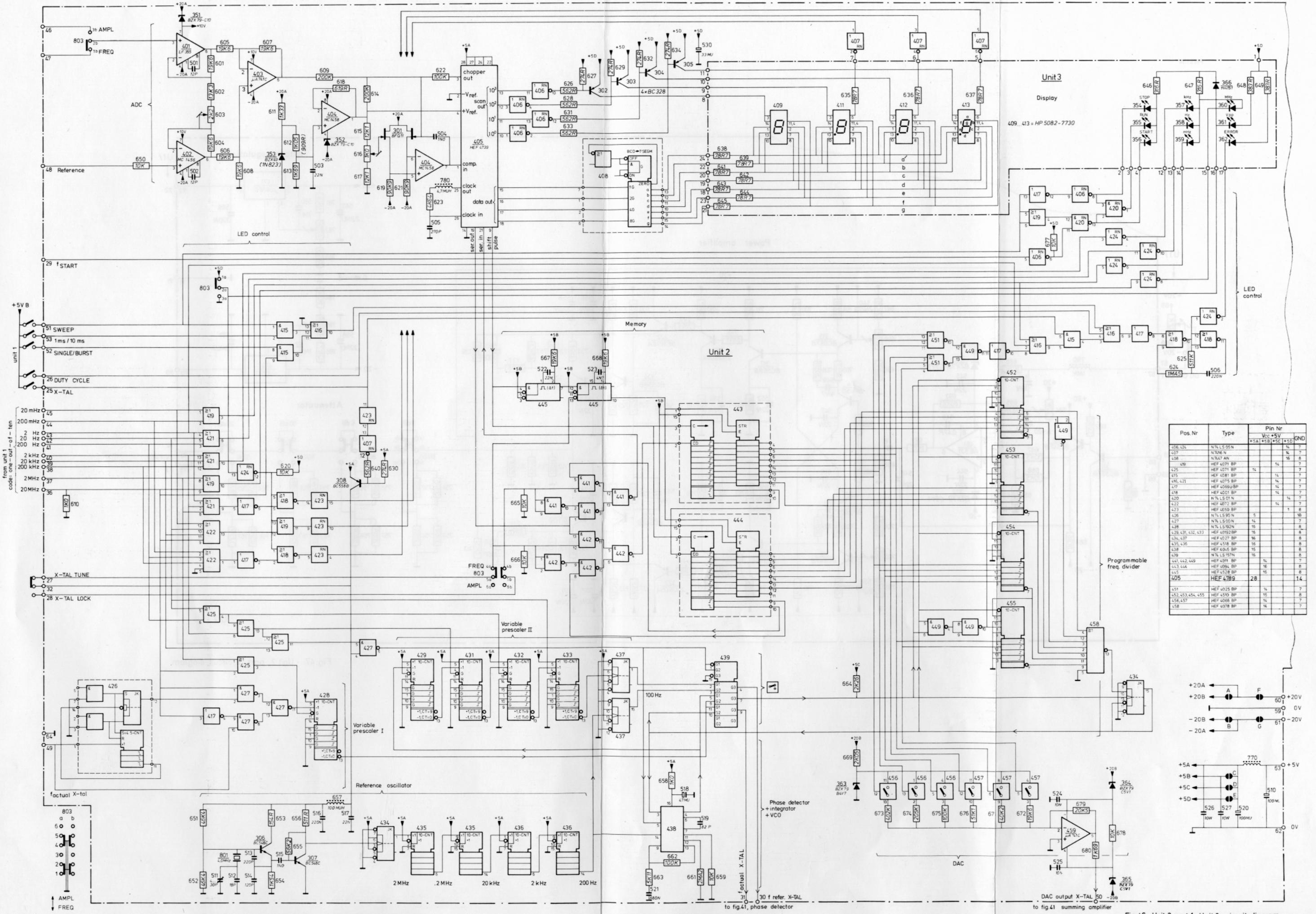


Fig.46 Unit 2, part 1; Unit 3; circuit diagram

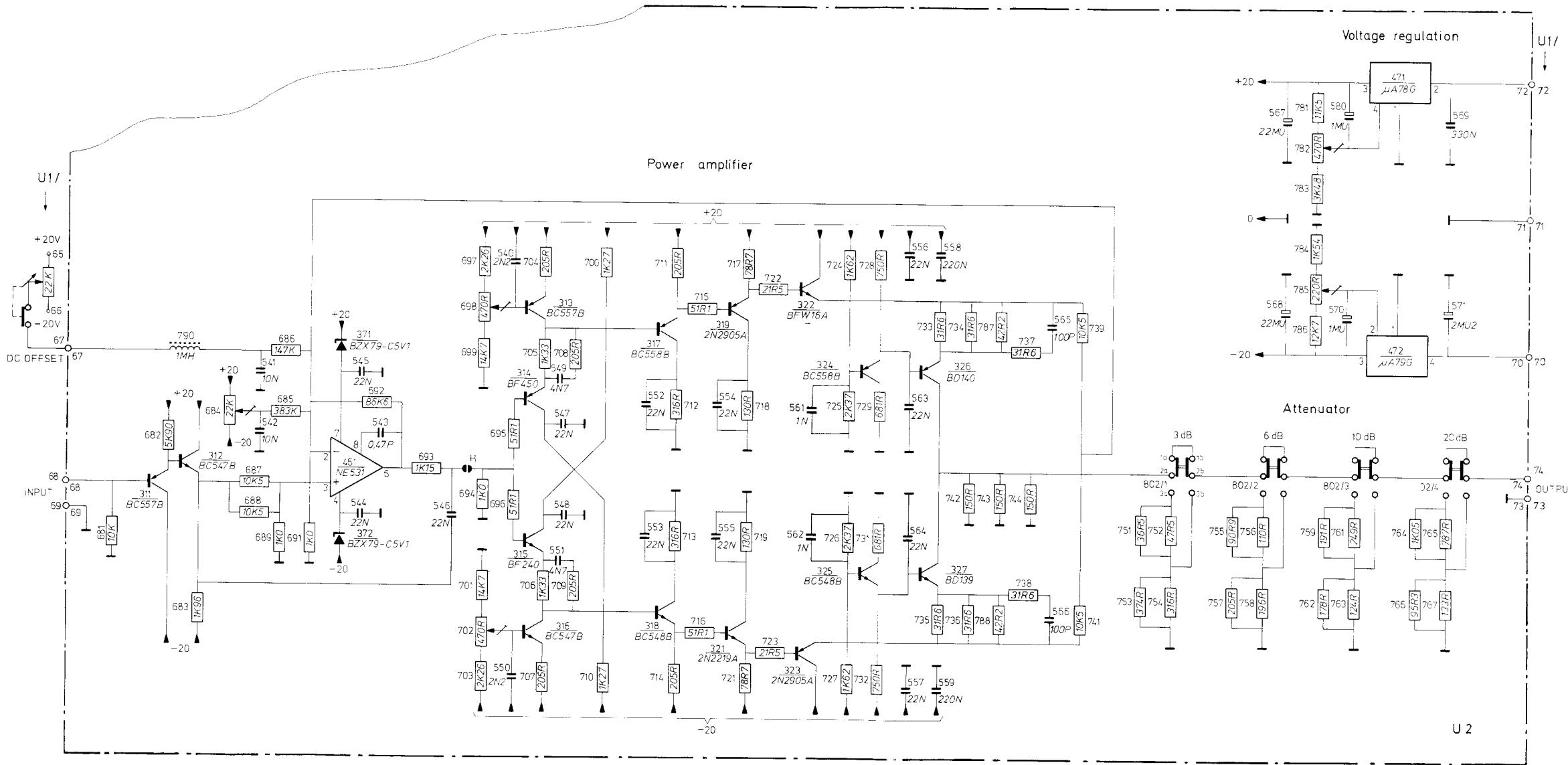


Fig. 47 Unit 2, part 2, circuit diagram

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY

ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber	/Version	④ Factory/Serial no.
3 2	1 5 0 4 7 5	0 P M 3 2 6 0 0 2		D O 0 0 7 8 3

CODED FAILURE DESCRIPTION

⑤ Nature of call	Location	Component/sequence no.	Category																																													
<input type="checkbox"/> Installation <input type="checkbox"/> Pre sale repair <input type="checkbox"/> Preventive maintenance <input checked="" type="checkbox"/> Corrective maintenance <input type="checkbox"/> Other	<table border="1" style="border-collapse: collapse; width: 100%;"> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td>0</td><td>0</td><td>2</td></tr> <tr><td></td><td></td><td>1</td></tr> </table>										0	0	2			1	<table border="1" style="border-collapse: collapse; width: 100%;"> <tr><td>T</td><td>S</td><td>0</td><td>6</td><td>0</td><td>7</td></tr> <tr><td>R</td><td>0</td><td>0</td><td>6</td><td>3</td><td>1</td></tr> <tr><td>9</td><td>9</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>	T	S	0	6	0	7	R	0	0	6	3	1	9	9	0	0	0	1													5 2 4
0	0	2																																														
		1																																														
T	S	0	6	0	7																																											
R	0	0	6	3	1																																											
9	9	0	0	0	1																																											
			7 <input type="checkbox"/> Job completed <input checked="" type="checkbox"/> Working time 8 <table border="1" style="border-collapse: collapse; width: 100%;"> <tr><td></td><td></td><td>1</td><td>2</td></tr> </table> Hrs			1	2																																									
		1	2																																													

Detailed description of the information to be entered in the various boxes:

① Country: **3 | 2** = Switzerland

② Day Month Year **1 | 5 | 0 | 4 | 7 | 5** = 15 April 1975

③ Type number/Version **O | P | M | 3 | 2 | 6 | 0 | 0 | 2** = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④ Factory/Serial number **D | O | 0 | 0 | 7 | 8 | 3** = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location	Component/sequence no.	Category															
<table border="1" style="border-collapse: collapse; width: 100%;"> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> </table> These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual). Example: 0001 for Unit 1 000A for Unit A 0075 for item 75 If units are not numbered, do not fill in the four boxes; see Example Job sheet.										<table border="1" style="border-collapse: collapse; width: 100%;"> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table> These six boxes are intended to pinpoint the faulty component. A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes. B. Parts not identified in the circuit diagram: 990000 Unknown/Not applicable 990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.) 990002 Knob (incl. dial knob, cap, etc.) 990003 Probe (only if attached to instrument) 990004 Leads and associated plugs 990005 Holder (valve,transistor, fuse, board, etc.) 990006 Complete unit (p.w. board, h.t. unit, etc.) 990007 Accessory (only those without type number) 990008 Documentation (manual, supplement, etc.) 990009 Foreign object 990099 Miscellaneous							<input type="checkbox"/> 0 Unknown, not applicable (fault not present, intermittent or disappeared) 1 Software error 2 Readjustment 3 Electrical repair (wiring, solder joint, etc.) 4 Mechanical repair (polishing, filing, remachining, etc.) 5 Replacement (of transistor, resistor, etc.) 6 Cleaning and/or lubrication 7 Operator error 8 Missing items (on pre-sale test) 9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

1 | 2 = 1,2 working hours (1 h 12 min.)

Sales and Service all over the world

Algeria
Bureau de Liaison Philips
24 rue Bougainville
El Mouradia, Alger
Tel: 60 14 05
TLX: 62221

Antilles
Philips Antillana N.V.
(For Philips products)
Schottegatweg Oost 146
PO Box 3523
Willemstad, Curacao
Tel: 599-9-615277
TLX: 1047
Tel: 599-9-414071/74*

Argentina
Philips Argentina S.A.
(For Philips products)
Cassilla Correo 3479
Vedia 3892
1430 Buenos Aires
Tel: 54-1-5414106/5417141
Tel: 54-1-5422411/5422451*
TLX: 21359/21243

Australia/New Zealand
Philips Scientific & Industrial PTY Ltd.
Test & Measurement Dept.
NZ Head Office
2 Wagner Place
PO Box 4021
Auckland 3
New Zealand
Tel: 09-894160
TLX: NZ 2395
Fax: 09-862728

Australia Head Office
Philips Scientific & Industrial PTY Ltd.
Test & Measurement Dept.
Centrecourt 25-27 Paul Street
North Ryde
Sydney New South Wales 2113
Tel: 02-888 0416
Tel: 02-888 8222*
Fax: 02-888 0440
TLX: AA 20165 philind ausnrsi

Philips Scientific & Industrial PTY Ltd.
Test & Measurement
23 Lakeside Drive
East Burwood
Melbourne Victoria 3151
Tel: 03-235 3666
Fax: 03-235 3618

Philips Scientific & Industrial PTY Ltd.
Test & Measurement
348 Torrens Road
Croydon
Adelaide South Australia 5008
Tel: 08-3482888
Fax: 08-3482813

Philips Scientific & Industrial PTY Ltd.
Test & Measurement
299 Montagne Road
West End
Brisbane Queensland 4101
Tel: 07-8440191
Fax: 07-8448537

Philips Scientific & Industrial PTY Ltd.
Test & Measurement
1 Frederick Street
Belmont
Perth West Australia 6104
Tel: 09-277-4199
Fax: 09-277-1202

Austria
Oesterreichische Philips Industrie GmbH
Geschaftsbereich I & E
Marktbereich Test und
Mesgeraten
Triesterstrasse 64
1101 Wien
Tel: 0222/60101 ext. 1772
TLX: 131670
Fax: 0222 6272165

Oesterreichische Philips* Industrie GmbH
Geschaftsbereich I & E
Technischer Kundendienst
Triesterstrasse 64
1101 Wein
Tel: 0222-60101 ext. 818

Bahrain
Messrs. Mohamed Fakhroo & Bros.
PO Box 439
Bahrain
Tel: 973-253529
TLX: 275996 bhxmaal/8679 alfaro bn

Philips Bangladesh Ltd.
(For Philips products)
PO Box 62, Ramna
16/17 Kawaran Bazar C/A
Dhaka
Tel: 411976
Tel: 234280*
TLX: 65668

Belgium
Philips Professional Systems S.A.
Test & Measurement Department
Tweestationstraat 80
1070 Brussel
Tel: 02-525 6692
Tel: 02 525 6694*
Fax: 02-230-2856*yhyg
TLX: 61511 belbrms
Fax: 02 525 6483

Philips do Brasil Ltd.
(For Philips Products)
Depto I & E
Ave Interlago 3493
04661 Sao Paulo S.P.
Tel: 55-11-5234811
TLX: (011) 32750
Fax: 55-11-5319549

Brunei (via Singapore)
(For Philips products)
Philips Project Development (S) PTY Ltd.
Lorong 1, Toa Payoh
Singapore 1231
PO Box 340 Tao Payoh C.P.O.
Tel: 65-3502000
TLX: philips rs/21375

Chile
Philips Chilena S.A. de Product Electr.
(For Philips products)
Avenida Santa Maria 0760
Casilla 2678
Santiago de Chile
Tel: 56-2-770038
TLX: 240239

China, Peoples Republic (via Hong Kong)
Philips Hong Kong Ltd.
(For Philips products)
29 F Hopewell Centre
17 Kennedy Road
G.P.O. Box 2108
Hong Kong
Tel: 852-5-283298
TLX: 73660 philh hx

Colombia
Industrias Philips De Colombia S.A.
(For Philips products)
Apartado Aereo 4282
Calle 13 No. 51-39
Bogota
Tel: 57 1-2600600
TLX: philcolon 44776

Cyprus
D. Ouzounian/ M. Soultanian & Co Ltd.
PO Box 1775
45 Evagoras Avenue
Nicosia
Tel: 357-2-442220
TLX: 2315 cy automobil
Fax: 357-2-459885

Denmark
Philips A/S Test & Measurement
Prags Boulevard 80
DK 2300 Kobenhavn S
Tel: (01) 572222
TLX: 31201
Fax: 01-570044

Ecuador
Philips Ecuador S.A.
(For Philips products)
Casilla 343
Paez 118 y Avenida Patria
Quito
Tel: 593-2-546100/546125
TLX: 2227 philpsq ed
Tel: 593-2-396100*

Egypt
Philips Egypt Liaison Office of Philips Middle East B.V.
10, Abdel Rahman el Rafei Street
PO Box 1687
Dokki, Cairo
Tel: 20-2-3490922
TLX: 22816 phegy un
Fax: 20-2-3492142

Ethiopia
(For Philips products)
Ras Abebe Areguay Avenue
PO Box 2565
Addis Ababa
Tel: 010-231-1-518300
Fax: 251-1-52845
TLX: 021319 phaddis

Finland
OY Philips AB
Sinikalliontie 3
PO Box 75
02631 Espoo
Tel: 0-50261 371
Fax: 0-529558
TLX: 1248 1150 Phil
Tel: 0-50261*
Fax: 0-529570*
TLX: 1248 1152 phil*

OY Philips AB*
Kaivokatu 8
PO Box 255
00101 Helsinki 10
Tel: 0-52571

Instrumentarium Elekronika*
PO Box 64 Vitikka 1
02631 Espoo 63
Tel: 0-5281

France
S.A. Philips Industrielle et Commerciaux
Division Science et Industrie
105 rue de Paris, BP 62
93002 Bobigny Cedex
Tel: (1) 49428100
Tel: (1) 49428000*
TLX: 210290

Germany
Philips GmbH - EWI Head Office
Miramstrasse 87
D-3500 Kassel
Tel: 0561-5010
TLX: 997070
Fax: 0561-501590

Sales and Service all over the world

Philips GmbH - EWI

Martin Luther Strasse 3-7
D 1000 Berlin 30
Tel: 030-21006364
TLX: 185532

Philips GmbH - EWI

Wieselweg 5
D 4300 Essen 11
Tel: 0201-3610-245
Tel: 0201-3610250*
TLX: 857-226
Fax: 0201-3610265

Philips GmbH - EWI

Th. Heuss Allee 106
D 6000 Frankfurt 90
Tel: 069-794093-31
TLX: 413611
Fax: 069-794093-91

Philips GmbH - EWI

Meiendorferstrasse 205
D 2000 Hamburg 73
Tel: 040-6797-278
Tel: 040-6797471*
TLX: 2116625

Philips GmbH - EWI

Ikarusallee 1A
D 3000 Hannover 1
Tel: 0511-6786-120
TLX: 923950

Philips GmbH - EWI

Oskar Messterstrasse 18
(For Fluke products)
D 8045 Ismaning
Tel: 089-9605-121
TLX: 21701380 phd, memo = de73txm

Philips GmbH - EWI

Kilianstrasse 142
D 8500 Nuernberg 12
Tel: 0911-3603293
TLX: 21701 380 phd, memo = de73txn

Philips GmbH - EWI

Hoehenstrasse 21
D 7012 Fellbach
Tel: 0711-5204-121
Tel: 0711-5204150*
TLX: 7254669
Fax: 0711-5204136

Great Britain

Philips Scientific Test & Measurement
Colonial Way
Watford Herts WD2 4TT
Tel: 0923-240511
TLX: 934583 phitmi
Fax: 0923-225067

Philips Scientific Test & Measurement

Yorkstreet
Cambridge CB1 2PX
Tel: 0223-358866
TLX: 817331 phsc cam g
Fax: 0223-321764

Greece

Philips S.A. Hellenique
PO Box 3153
15, 25th March Street
17778 Tavros/Athens
Tel: 030-1-4894911
TLX: 241566-241567
Fax: 030-1-4815180

Philips S.A. Hellenique*
PO Box 153
54 Ave Syngrou
Athens
Tel: 030-1-9215311

Hong Kong

Philips Hong Kong Ltd.
(For Philips products)
29/F Hopewell Centre
17 Kennedy Road
G.P.O. Box 2108
Hong Kong
Tel: 852-5-283298
TLX: 73660 philh hx

Iceland*

Heimeliteki S.F.
(For Philips products)
Saetun 8
Reykjavik
Tel: 24000

India

Peico Electronics &
Electricals Ltd.
I & E Division
39-43 Nesbit Road, Mazgaon
PO Box 6236
Bombay 400 010
Tel: 022 8510261
TLX: 011 75849 indbnp
Fax: 022 4941698

Peico Electronics & Electricals Ltd.

I & E Division
7 Justice Chandra
Madhab Road
Calcutta 700 020
Tel: 473621

Peico Electronics & Electricals Ltd.

I & E Division
Band Box House
254 Dr. Annie Besant Road
Bombay 400 025
Tel: 022 4930311/4930590
TLX: 011 71540

Peico Electronics & Electricals Ltd.

I & E Division
68, Shivaji Marg
New Delhi 110 015
Tel: 530153
Tel: 533956/57*
TLX: 031 3142

Peico Electronics & Electricals Ltd.

I & E Division
No 3 Haddows Raod
Madras 600 006
Tel: 472341
TLX: 041 499

Peico Electronics & Electricals Ltd.

I & E Division
7311 St Mark's Road
Bangalore 560 001
Tel: 579119/579164
TLX: 0845-8185

Indonesia

P.T. Daeng Brothers
(For Philips products)
Centre Point Building, 3rd Fl.
Jalan Gatot Subroto Kav. 35/36
PO Box 41 Tebet
Jakarta
Tel: 62-21-517900
Tel: 62-21-577335*
TLX: 62798 phdc ia

Iran

Philips Iran Ltd.
Private Joint Stock Comp.
PO Box 11365-3891
Tehran
Tel: 98-21-674138/675158
TLX: 212545 phps ir

Iraq

Philips Middle East B.V.
Baghdad Branch
Hai Al Whida, Area No. 902
Street No. 12, Bldg. 141/10
PO Box 5749
Baghdad
Tel: 964-1-7182467
TLX: 212439 philips ik

Philips Iraq W.L.L.*

Munir Abbas Building
4th Floor South Gate
PO Box 5749
Baghdad
Tel: 964 1 880409

Ireland

P.J. Brennan and Company Ltd.
(for Phillips products)
61 Stillorgan Industrial Park
Stillorgan, Co. Dublin
Tel: 952501
TLX: 3817
Fax: 952333

Italy

Philips S.p.A.
Sezione S & I, T & M Dept.
Viale Elvezia 2
20052 Monza
Tel: (039) 3635240/8/9
TLX: 333343
Fax: 039-3635309

Japan

NF Circuit Design
Block Co., Ltd.
(For Philips products)
3-20 Tsunashima Higashi, 6
Chome,
Kokokuku, Yokohama 223
Tel: (045) 452-0411
TLX: 3823-297

Japan

Nihon Philips Corporation*
Shuwa Shinagawa Building
26/38 Tahanawa 3-Chome
Minatu-ku Tohyo 108
Tel: 4485511

Jordan

Jordan Medical Supplies &
Services
PO Box 140415
Al Biader
Amman Jordan
Tel: 962-6-819929
TLX: 22161 jms jo
Fax: 962-2-823556

Kenya

Philips Kenya Ltd.
(For Philips products)
Ol Kalou Road, Industrial Area
PO Box 30554
Nairobi
Tel: 254-2-557999
TLX: 24033

Korea, Republic of

Myoung Corporation
(For Fluke products)
Yeo Eui Do
PO Box 14
Seoul Korea
Tel: (82) (2) 784-9942
TLX: MYOUNG K24283
Fax: (82) 2-784-2387

South Korea

Philips Industries (Korea) Ltd.
(For Philips products)
C.P.O. Box 3680, Philips House
260-199, Itaewon-Dong
Youngsan-Ku
Seoul
Tel: 82-2-794-5011/5
TLX: philkor k 27291

Lebanon

Az. Electronic SAL
PO Box 11-2833
Byrooth
Tel: 387202/382303
TLX: azelec 22831 le

Philips Middle East S.A.R.L.*

PO Box 11-670
Ave. Sami Solh
Byrooth
Tel: 285748/9

Luxemburg

Philips Luxembourg
Professional Systems
4 rue des Joncs
1818 Howal
Tel: 352-49611
TLX: 60572
Fax: 352 400577

Malaysia

Philips Electronic Systems
Malaysia Sdn Bhd
Wisma Philips 3 Jalan SS15/2A
Subang Jaya
47500 Petaling Jaya
Selangor Kuala Lumpur
Tel: 60-3-7345511
TLX: philmal ma 25111

Sales and Service all over the world

Malta

Charles A. Micallef & Co., Ltd.
 PO Box 527
 217 St Paul Street
 Valletta
 Tel: 234313/233506
 TLX: 1651 micamw

Morocco

Samtel*
 2 Rue de Bapaume
 Casablanca
 Tel: 243050

Somaciel

304 Boulevard Mohammed V
 Casablanca 05
 Tel: 308051/52
 TLX: 27021

Nepal

Bahajurana Engineering & Sales (P) Ltd.
 (For Philips products)
 Jyoti Bhawan
 PO Box 133 Kantipath
 Kathmandu
 Tel: 2-25134
 TLX: jyoti np

Netherlands

Philips Nederland
 Test en Meetapparaten
 Hoevenseweg 55A
 5000 AC Tilburg
 Postbus 115
 Tel: 013-352455
 TLX: 52683
 Fax: 013 427528

Philips Nederland

Technische Service Prof. Akt.*
 Huksestraat 2C
 Gebouw HCR
 5652 AJ Eindhoven

New Zealand

Philips Scientific Test & Measurement
Industrial PTY Ltd.
 2 Wagner Place
 PO Box 4021
 Auckland 3
 Tel: 09-084-160
 TLX: N2 2395
 Fax: 09-862728

Nigeria

Associated Electronic Products (Nigeria) Ltd.
 (For Philips products)
 KM 16, Ikorodu Road, Ojota
 PO Box 1921
 Lagos
 Tel: 234-1-900160/69
 Tel: 234-1-932825*
 TLX: 21961 NG

Norway

Norsk Philips AS
Dept. I & E Test & Measurement
 Sandstuveien 70
 PO Box 1 Manglerud
 0612 Oslo 6
 Tel: 47-2-356110
 Tel: 47-2-680200*

TLX: 856-71719
 Fax: 47-2-381457

Oman

Messrs. Mustafa Jawad Trading Co.
 PO Box 4918
 Ruwi, Sultanate of Oman
 Tel: 968-709955
 TLX: 3731 mujatru on
 Fax: 968-7972 77

Pakistan

Philips Electrical Co. of Pakistan Ltd.
 (For Philips products)
 PO Box 7101
 M.A. Jinnah Road
 Karachi 3
 Tel: 92-21-725772/9
 TLX: 2874 phpak pk

Paraguay

Philips del Paraguay S.A.
 (For Philips products)
 Avenida Artigas 1519
 Casilla de Correo 605
 Asuncion
 Tel: 595-21-291924
 TLX: py 215

Peru

Philips Peruana S.A.
 (For Philips products)
 Av. Alfonso Ugarte 1268
 Lima 5 Apartado 1841
 Lima 100
 Tel: 51-14-326070
 TLX: 21678 pe philper

Philippines, Republic of
Philips Industrial Development Inc.
 (For Philips products)
 2246, Pasong Tamo
 PO Box 911
 MCCPO Makati Riazal D
 Metro Manila
 Tel: 63-2-868951

Portugal

Philips Portuguesa, S.A.R.L.
Division of I & E Test & Measurement
 (For Philips products)
 Outurila-Cavinaxille
 2795 Linda-A-Velha
 Tel: 1-2190071
 TLX: 65120/42987
 Fax: 1-2187656

Philips Portuguesa*
Division I & E

Rua Eng Esequil de Campos 182
 4100 Porto
 Tel: (2) 678278
 TLX: 28790

Qatar

Darwish Trading Company
 PO Box 92
 Doha, Qatar
 Tel: 974-422781 ext 228
 TLX: 4298 tradar dh

Saudi Arabia

Messrs. A. Rajab & Silsilah Head Office
 PO Box 203
 Jeddah 2141
 Tel: 966-2-6610006
 TLX: 601180 arndas sj

Messrs. A. Rajab & A Silsilah

PO Box 260
 Ryadh 1141
 Tel: 966-1-4122425
 TLX: 404787 arndas sj

Messrs. A. Rajab & Silsilah
 PO Box 587
 Damman
 Tel: 966-3-8322596/83318870
 TLX: 601044 arndas sj

Singapore

Philips Project Development (S) PTY Ltd.

(For Philips products)
 Lorong 1, Toa Payoh
 Singapore 1231, PO Box 340
 Toa Payoh Central Post Office
 Singapore 9131
 Tel: 65-3502000
 TLX: philips rs/21375

South Africa

South African Philips PTY Ltd.
I & E division Test & Measurement
 10 Bondstreet, Randburg
 Johannesburg 2000
 Tel: 27-11-889-3911
 TLX: 4-26152-sa

Fax: 27-11-889-3098/889 3191

South African Philips PTY Ltd.*
I & E Customer Support Centre
 195 Main Road, PO Box 58088
 Martindale, New Ville 2092
 Tel: 27-11-470-5937
 TLX: 4-26152 SA
 Fax: 27-11-470-5166

Spain

Philips Iberica SAE
 Depto Instrumentacion de Medida
 Poligono Industrial Zona Franca
 Sector C-calle F
 08004 Barcelona
 Tel: 34-3-3361061
 TLX: 51293/59292
 Fax: 34-3-3355838

Philips Iberica*

Depto Instrumentacion de Medida
 Martinez Villergas 2
 28027 Madrid
 Tel: 34-1-4043200
 TLX: 27710
 Fax: 34-1-4048603

Philips Iberica SAE*

Jose Olabarria 6
 48012 Bilbao
 Tel: 34-4-4313800
 TLX: 31230
 Fax: 34-4-432 0961

Sri Lanka

Hayleys Electronics & Engineering Ltd
 PO Box 70
 400 Deans Road
 Colombo 10
 Tel: 599087-100
 TLX: 21146/21384

Sweden

Philips Kistaindustrier AB
 PO Box 33
 16493 Kista
 Tel: 08-7031000
 TLX: 17173 philkis
 Fax: 08-752 0831

Svenska A.B. Philips*

Div. Industrielektronik
 Avd. Matinstrument
 11584 Stockholm
 Tel: 782-1800

Switzerland

Philips AG Test und Messtechnik
 Postfach 670
 8027 Zurich
 Tel: 01 4882390
 TLX: 815780-0

Philips SA

Test et Mesure
 Avenue du Mont Blanc
 1196 Gland
 Tel: 022/647171

Syria

Philips Moyen-Orient S.A.R.L.
 (For Philips products)
 Rue Fardoss 79
 PO Box 2442
 Damascus
 Tel: 218605/221650
 TLX: phisyr 411203 sy

Taiwan

Philips Taiwan Ltd.
 (For Philips products)
 150, Tun Hua North Road
 PO Box 22978
 Taipei
 Tel: 886-2-7120500
 TLX: 21570 philipei

Tanzania

Philips (Tanzania) Ltd.
 (For Philips products)
 T.D.F.L. Building - 1st Floor
 PO Box 20104
 Ohio/Upanga Rd.
 Dar es Salaam
 Tel: 29571/4
 TLX: 41016

Sales and Service all over the world

Thailand
Philips Electrical Co. of Thailand Ltd.
(For Philips products)
283, Silom Road
PO Box 961
Bangkok 10500
Tel: 66-2-233-6330/9
TLX: 87327 philtha th

Tunisia
S.T.I.E.T.
(For Philips products)
32 bis rue Ben Ghedahem
Tunis
Tel: 348666
TLX: 14512

Turkey
Turke Philips Ticaret Anonim
Sirketi
Talacpanumbera Cadessi 5
PO Box 161
80640 Levant
Tel: 90-1-792770

Turk Philips Ticaret*
Posta Kutusu 504
Beykoglu Istanbul
Tel: 1435910

United Arab Emirates
Al Sanai Trading Estate
PO Box 7187
Abu Dhabi UAE
Tel: 971-2-23966
TLX: 23966 Sanani em

Haris Al Faraq Ltd.
PO Box 8141
Dubai UAE
Tel: 971-4-283625
TLX: 48168 Afaq em

Philips Middle East*
Dubai Intern. Trade Centre,
11th Floor
PO Box 9269
Dubai UAE
Tel: 971-4-377000
TLX: 46350 pmoa em

Uruguay
Industrias Philips del Uruguay S.A.
(For Philips products)
Av. Uruguay 1287
Casilla de Correo 294
Montevideo
Tel: 919000
Tel: 915641*
TLX: philuru uy 22296

Venezuela
Inds. Venezolanas Philips S.A.
(For Philips products)
Av. Francisco de Miranda
Urb. La Carlota,
Edf. Centro Empresarial Parque
del Este
Apartado 1167
Caracas 1010-A
Tel: 58-2-203.71111
TLX: 25267 ivpsa vc

Yemen, Arab Republic
Rashed Trading & Travel Agency
PO Box 1211
Sana 'A, Yemen
Tel: 967-2-226067
TLX: 2230 abgar ye

Zaire
Philips Electronics S.A.R.L.
(For Philips products)
137 Boulevard du 30 Juin
B.P. 16636
Kinshasa
Tel: 31693
TLX: 21078 kinshasa

Zambia
Philips Electrical Zambia Ltd.
(For Philips products)
Mwenbeshi Road
PO Box 31878
Lusaka
Tel: 218511/218701
TLX: za 41220

Zimbabwe
Philips Electrical (Pvt.) Ltd.
(For Philips products)
62 Mutare Road
PO Box 994
Harare
Tel: 47211/48031
TLX: 2236

For countries not listed above:
Philips Export B.V.
I & E Export
Test & Measurement
Building HVW-3
PO Box 218
5600 MD Eindhoven
The Netherlands
Tel: +31 40 711546
TLX: 35000 phtc nl
Fax: +31 40 711508